

USE OF A COMPUTER-AIDED DIAGNOSIS SYSTEM
ABOARD PATROLLING FBM SUBMARINES:

Initial At-Sea Trials

by

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SUMMARY PAGE

THE PROBLEM

At-sea testing for user acceptance and unanticipated problems in deployment of a computer-based system to aid in medical decision making aboard patrolling nuclear submarines. This testing is preparatory to fleet-wide clinical trials of this system.

FINDINGS

The use of simulated patients provided for realistic use of the medical computer system during at-sea trials. The system had a positive effect on the Corpsman's professional role and on his interactions with his Commanding (CO) and Executive (XO) Officers. Corpsmen, CO's and XO's all found the system acceptable and useful in making medical-evacuation (MEDEVAC) and other patient-care decisions. Other findings, and recommendations, are presented.

APPLICATION

This study justifies proceeding with a major clinical trial of a computer-based medical decision system throughout the nuclear submarine fleet. This system, if successful in its further testing, will help preserve the strength of the submarine force by decreasing MEDEVACs and improving patient care.

ADMINISTRATIVE INFORMATION

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Abstract

This report describes experience in using a computer-based system to aid in medical decision making aboard patrolling nuclear submarines. The system consists of a Tektronix 4051 desk-top microcomputer, already aboard submarines, and a computer program designed to assist hospital corpsmen in the diagnosis of patients with acute abdominal pain. This trial was designed to test user acceptance and to find whether unanticipated problems might be encountered during operational use of the system. Participating submarine Corpsmen, Executive Officers (XO), and Commanding Officers (CO) subjectively assessed whether the trials permitted realistic use of the system, whether the system affected the Corpsman's professional role or his interactions with his XO or CO, and whether the system was useful in making medical evacuation (MEDEVAC) or other patient care decisions while at sea.

Four Fleet Ballistic Missile Submarines participated, each for one 2-month patrol. Each had a single Corpsman, XO, and CO. To ensure use of the system in a predictable way, preselected submarine crewmembers, trained to simulate abdominal pain, presented to the corpsman for diagnosis during patrol. The corpsmen did not know in advance that a given case might not be real. CO's and XO's also participated in each drill as if the patient were genuine, though they knew in advance that they were not. At the end of patrol, each Corpsman, XO, and CO was interviewed and these interviews were recorded and transcribed in toto.

During the study, 9 simulated and 4 genuine cases of abdominal pain were evaluated. In debriefings, all participants stated that the simulated patients appeared genuine and that this method provided for realistic use of the system. All corpsmen perceived the computer as an aid to, rather than a replacement for, their clinical judgment. The Corpsmen, and particularly the XO's and CO's, found the computer programs valuable in organizing and summarizing patient data and provided a basis for discussing MEDEVAC decisions. All stated that the system was useful in making MEDEVAC and other patient-care decisions and unanimously endorsed its use aboard submarines at sea.

Significant problems were that users found the results of the computer analysis difficult to interpret and that the hardcopy unit failed to provide legible computer printouts in 3 of 4 cases. We conclude that prior to full-scale clinical trials of this system at sea, the computer "diagnosis" must be presented in a format which is easily interpreted and most useful in making patient care decisions. Training of users in interpreting the computer output must also be improved. Failure of the hardcopy unit can be avoided by providing copy paper that is fresh and stored in a cool environment.

USE OF A COMPUTER-AIDED DIAGNOSIS SYSTEM ABOARD PATROLLING FBM SUBMARINES: INITIAL AT-SEA TRIALS

1. INTRODUCTION

Aboard a nuclear submarine on patrol and under radio silence, the Hospital Corpsman faced with an acutely ill patient must make several difficult decisions. In addition to the immediate concerns of patient care, which he must perform with limited diagnostic and therapeutic tools, questions of diagnosis and prognosis, and treatment also impinge significantly on the mission of the submarine. This is especially true when management of the patient requires that he be evacuated to a primary care facility (MEDEVAC). Because a MEDEVAC exposes the submarine's position, its mission is for a period compromised, a condition which can detract from our country's ability to retaliate if attacked with nuclear weapons. Thus, the national defense can be affected by a MEDEVAC.

There are other reasons for making the MEDEVAC decision a careful one. MEDEVACs, especially in heavy seas, are hazardous to patients and rescuers alike. Also, a single MEDEVAC can be expensive, sometimes involving movements of large numbers of ships, aircraft, and men.

However, the Navy's policy toward MEDEVAC has been a permissive one, since failure to evacuate a patient who cannot be adequately managed on board could jeopardize the patient's life. As a consequence, in over 20 years experience aboard nuclear submarines, there have been no fatalities resulting from an inappropriately avoided MEDEVAC.

But there have been several unnecessary MEDEVACs.

In an effort to reduce unnecessary MEDEVACs and improve patient care aboard submarines, we have been developing an on-board microcomputer-based, medical support system to aid the Submarine Corpsmen. In its eventual form, programs will be provided in two main areas: real-time patient management, including diagnosis, prognosis, and treatment of common medical problems such as abdominal and chest pain; and computer-assisted instruction for continuing medical education while on patrol (e.g., in cardiopulmonary resuscitation) and to complement the patient management programs (e.g., simulation of patients with acute abdominal pain). The system is implemented on a computer which is already aboard submarines for other applications. Programs are provided on a magnetic tape cartridge.

Since nearly half of MEDEVACs involve patients with acute abdominal pain (1,2,3), we began our efforts in this area. A review of the literature revealed one computer system with demonstrated clinical effectiveness in aiding diagnosis of acute abdominal pain. The system, developed by deDombal and his associates at the University of Leeds, England, appeared well-suited to our purposes since computer-aided diagnosis is made without laboratory tests, can be implemented on a microcomputer, and has a diagnostic accuracy (91%) exceeding that of junior (42%) and senior (82%) clinicians (4). In hospitals serving 2% of the UK

population, use of the computer has been associated with significant decreases in the negative laparotomy and perforated appendix rate, and with shortened hospital stays (5). The program employs a Bayesian analysis of a data base, constructed from clinical information gathered prospectively from a general population of abdominal pain patients in Leeds, England.

In collaboration with Dr. deDombal, we have adapted this program for use aboard submarines by constructing a data base suited to our population (young, healthy males, seen within the first 48 hours of illness) and by developing supporting programs to generate data collection forms, give definitions and instructions, and to guide patient disposition and initial therapy. We have also devised, in collaboration with the Naval Health Sciences Education and Training Command, curricula and materials for training Corpsmen in methods of gathering clinical data and in use of the computer and programs (6). In implementing this system, training of users is extremely important (5).

We conducted clinical trials of the adapted system at the Emergency Room at the Naval Regional Medical Center, San Diego, CA, using students completing their training at the Independent Duty Technician (IDT) School, Naval Health Sciences, San Diego, CA. 138 young, male patients presenting with previously undiagnosed acute abdominal pain were evaluated by IDT students, who gathered appropriate clinical data and entered those data into the computer. Overall diagnostic accuracy of the adapted program in this series was 72%. This

can be compared with an unaided diagnostic accuracy of Navy doctors of 78% in the same series and of English house surgeons of 72% in a different series. A preliminary report of these results has been published (7).

Having completed clinical evaluation of the program in a hospital setting, we now wish to test the system during operational use at sea. The medical screening of selectees for submarine duty is thorough and the incidence of acute illness is relatively low (2,3). Thus, clinical testing of the system at-sea will be necessarily large scale, involving large numbers of men and submarines and extending over several years. Preparatory to such an effort, we conducted a pilot study to assess the system's acceptability and to determine whether unanticipated problems might be encountered during operational use of the system. To circumvent the problems of low incidence of illness and to ensure use of the system predictably, we used simulated patients. Submarine crewmembers, trained to simulate acute abdominal pain without the Corpsman's prior knowledge, presented themselves for diagnosis and possible treatment during submarine patrols. This paper describes these sea trials.

2. METHODS

Equipment for the study consisted of a Tektronix 4051 desk-top microcomputer and associated Tektronix 4631 Hard-copy Unit. These computers are already aboard most U.S. Navy nuclear submarines for tactical purposes. The computer has 32 kilobyte rapid access memory and an integral 3-M cartridge magnetic tape storage device

capable of storing up to 300 kilobytes per cartridge. Tapes containing the program were provided in duplicate to each submarine's corpsman, the second copy to be retained by the XO in the ship's safe. A complete description of the abdominal pain system is published elsewhere (6).

Preparation. Four Fleet Ballistic Missile (FBM) Submarines participated in the pilot study, each for one 2-month patrol. Participants aboard each submarine were a single Corpsman, Executive Officer (XO), and Commanding Officer (CO), as well as one or more crewmembers trained to simulate abdominal pain. The submarines, and consequently their crews, were selected for convenience of their deployment schedule. The crewmembers acting as patients were nominated by the respective XO's; criteria for nomination of crewmembers aside from willingness to participate are uncertain, but most weight appears to have been given to the men's availability for training as patients.

In briefings of CO's and XO's, the purpose and method of the study were explained. All CO's and XO's agreed to participate and to treat each patient simulation realistically.

Corpsmen were trained in a 20-hour lecture/workshop, including a general orientation to computer-aided diagnosis and instruction in specific methods

of gathering history and physical examination, with emphasis on the need for accuracy in data gathering. Hands-on experience in performing the specific physical examination required to use the system and in use of the computer itself were also provided. Throughout the training sessions emphasis was placed on viewing the computer as a clinical tool and not as a replacement for the corpsman's own clinical judgment.

Training of the simulated patients took about 8 hours, including 3 hours spent in evaluation and videotaping of each participant. Initially, the purpose and method of this study was explained. Following this, each of the 12 selected crewmembers volunteered to participate in the study and gave informed consent to undergo a complete history and physical examination including rectal examination and venipuncture. A group interview was then conducted, which served as an "icebreaker" and assisted in assigning patient roles. The 12 participants were then divided into one of 3 groups each having 4 members. Group A was trained to demonstrate "classic" and clear-cut appendicitis; Group B rather vague, non-specific abdominal pain; and Group C possible but not "classic" appendicitis. Table 1 shows presenting history and physical findings which were designed to produce computer possibilities which clearly favored appendicitis in Group A patients, clearly non-specific pain in Group B patients, and did not clearly favor any diagnosis in Group C patients.

Table 1

History and Physical Findings in Simulated Patients

GROUP A: APPENDICITIS	GROUP B: NON-SPECIFIC ABDOMINAL PAIN	GROUP C: POSSIBLE, NOT "CLASSIC" APPENDICITIS
Male	Male	Male
Age 20-29	Age 20-29	Age 20-29
Pain Onset Central	Pain Onset Rt. Lower Quad	Pain Onset Upper Half
Pain Now Rt. Lower Quad	Pain Now Rt. Lower Quad	Pain Now Lower Half
Cough & Movement Aggravates	No Aggravating Factors	No Aggravating Factors
Relieved by Lying Still	Nothing Relieves Pain	Nothing Relieves Pain
Severity Unchanged	Severity Unchanged	Severity Now Worse
Pain Duration 12-24 Hours	Pain Duration < 12 Hours	Pain Duration 12-24 Hours
Pain Now Steady	Pain Now Intermittent	Pain Now Steady
Severity Now Moderate	Severity Now Moderate	Severity Now Moderate
Nausea is Present	No Nausea	Nausea is Present
Vomiting Present	No Vomiting	No Vomiting
Appetite Decreased	Appetite Normal	Appetite Decreased
No Previous Indigestion	No Previous Indigestion	Previous Indigestion
No History of Jaundice	No History of Jaundice	No History of Jaundice
Bowels Normal	Bowels Normal	Bowels Normal
Urination Normal	Urination Normal	Urination Normal
No Previous Similar Pain	No Previous Similar Pain	No Previous Similar Pain
No Previous Abdominal Surgery	No Previous Abdominal Surgery	No Previous Abdominal Surgery
Not Taking Medications	Not Taking Medications	Not Taking Medications
Distressed Mood	Anxious Mood	Distressed Mood
Normal Color	Normal Color	Normal Color
Abdominal Inspection Normal	Abdominal Inspection Normal	Abdominal Inspection Normal
No Abdominal Scars	No Abdominal Scars	No Abdominal Scars
No Abdominal Distension	No Abdominal Distension	No Abdominal Distension
Tenderness Rt. Lower Quad	Tenderness Rt. Lower Quad	Tenderness Lower Half
Rebound Tenderness	No Rebound	No Rebound
Guarding Present	Guarding Present	Guarding Present
No Rigidity	No Rigidity	No Rigidity
No Abdominal Mass	No Abdominal Mass	No Abdominal Mass
Murphy's Sign Negative	Murphy's Sign Negative	Murphy's Sign Negative
Bowel Auscultation Normal	Bowel Auscultation Normal	Bowel Auscultation Normal
Rectal Exam Normal	Rectal Exam Normal	Right Rectal Tenderness

These profiles were designed to test the system's use in conditions of differing severity and difficulty of diagnosis. The profiles also addressed the MEDEVAC question since the Group A patients were clearly candidates for evacuation, Group B were clearly not, and Group C might be.

Care was taken to describe procedures and findings in lay language and the use of medical terms was avoided. We did not wish the patients to become suspiciously educated. Though we specified the symptoms, signs, and general affect they should assume, we emphasized that their mood be consistent with their normal, expectable behavior and that answers they gave to any unanticipated questions from the Corpsman be actually true for them, e.g. their recent activities or their medical or surgical history. Fortunately for this study, none of the volunteers had a history of intraperitoneal surgery such as appendectomy or cholecystectomy, which would have constrained the diagnostic possibilities. Also, note in Table 1 that we used only findings that could be readily simulated without special preparation, i.e., a participant need not apply makeup or take medication to simulate bowel sounds. The Groups A and C patients were told that they might drink hot coffee immediately before visiting the Corpsman to elevate the oral temperature. (This was done in only one case and worked well, except when the patient was caught unprepared.)

The participants then practiced undergoing history and physical

examinations within their respective groups. During this time, emphasis was placed on the believability of their presentation, especially that they not appear practiced.

The next morning the "patients" were examined and rated for realism by our group and by corpsmen and physicians at the Naval Undersea Medical Institute (NUMI). These examinations were videotaped for further analysis and use in other phases of our research. As an additional check on their training, four of the simulated patients presented to the Emergency Room at the Naval Submarine Medical Center, Groton, CT, for diagnosis and possible treatment by the NUMI student Corpsman on duty.

The Patrol. At sea trials, our simulated patients began having their symptoms at designated times, contingent on the submarine's mission requirements and after notifying their respective XO's and CO's. The Corpsmen were not told in advance that they might be seeing simulated patients during patrol. Although they were aware that the patients were not genuine, the XO's and CO's participated as though the patients being evaluated were truly ill. Their decision regarding possible medical evacuation of the patients were made according to factors that might normally be weighed: patient status, the submarine's mission and its position, the sea state, the position of other deployed vessels, etc. The Corpsmen were not told that a patient was not genuine until after the drills were completed. The Corpsmen were expected to use the prescribed method for taking history and performing the physical examination and to complete the

data sheets, enter this information into the computer and obtain a printout of the results (Figure 4), and to notify the XO and CO of their decisions regarding diagnosis and disposition of the patient. However, in practice, this was done only in cases they considered "serious", i.e., Groups A and C.

Two types of end points were designated for the drills: either the Corpsman decided to treat and/or evacuate for serious illness, or he decided to treat and/or observe for non-serious illness and the period of the drill exceeded 3-5 days. In order to protect the reputation of the Corpsman, the "correct diagnoses" were never revealed.

Debriefings: During debriefings after completion of their patrols, all Corpsmen, XO's and CO's were interviewed. Debriefings were taped, transcribed, and edited. Excerpts were made of comments bearing on whether these trials provided realistic opportunities to evaluate the computer/programs system; whether the system influenced the corpsman's professional self-image or interactions with his superior officers; and whether the corpsman, XO, and CO found the system useful in making diagnosis or MEDEVAC decisions.

3. RESULTS

During our initial assessment of the simulated patients, one of the 12 was rated unrealistic (later devolunteered), 3 were rated realistic, and 8 were rated as very realistic. When 4 simulated patients presented to the Emergency Room (ER) at the Submarine Medical Center, in 3

cases the Corpsman on duty had no suspicions that the patient was simulating illness. In the fourth, the Corpsman questioned the patient's authenticity because he had examined a similar simulated patient during his previous ER watch.

During the sea trials, 9 of the 12 participating crewmembers actually presented as patients, two having devolunteered (one B and one C) and one having been left ashore for humanitarian reasons (Group A). A letter from the research team, explaining the purpose of using simulated patients, was given to the Corpsman by the XO after the first drill ended. In patients from Groups A and C, the Corpsmen used the data sheets and computer and presented the computer results in his discussion with the XO and CO. In the three Group A "classic" appendicitis patients, the Corpsmen made a decision to treat with intravenous antibiotics and recommended evacuation; these drills were quickly terminated before therapy was begun. In the Group C patients, all Corpsmen elected to not treat and observe these patients. However, in one case the corpsman suspected malingering because word reached the corpsman that his patient was ill only in the corpsman's presence. In another Group C patient, the patient was convincing in the initial examination but not during re-examination and the corpsman began to suspect that he might not be genuine. In two of the Group B patients, the datasheets and computer were not used because the

illness was considered trivial. The Group B patients were treated symptomatically with antacids or aspirin (patients did not actually take medication) and observed; the patients ended these drills after 3-5 days.

In the real cases of abdominal pain, one patient had appendicitis, for which he was evacuated. The remainder were in the non-specific abdominal pain category; i.e., they resolved during the patrol and required no specific intervention. The computer-assisted diagnosis was correct in all cases. One patient in the NSAP category had such severe abdominal pain that he required a narcotic analgesic and the corpsmen was considering a diagnosis of small bowel obstruction. Datasheets, computer printouts, questionnaires, and debriefing excerpts on this patient and the one with appendicitis are given in Appendix A. Figures 1-4 show datasheets and computer output for the patient with appendicitis.

The Tektronix 4051 microcomputer performed well in all instances. One tape cartridge failure occurred, requiring that the back-up tape be used. The 4631 hard copy unit performed well on only one submarine. On the others, copies were nearly illegible, and in one instance the copy unit failed completely. All corpsmen felt that interaction with the computer was acceptable, though two felt that the format for the entry of signs and symptoms could be improved.

Debriefings

Edited debriefings for all Corpsmen and, jointly, all CO's

and XO's are included in Appendix A and B, respectively. Below are excerpts of these transcripts containing remarks bearing on three major conclusions.

Conclusion #1: Trials permitted a realistic assessment.

Submarine #1: Corpsman and CO/XO:
[No excerpt. Had three actual cases, one MEDEVAC'd.]

Submarine #2: Corpsman: I had absolutely no suspicions ... [The simulated patient] was convincing ... It's hard to duplicate or fake a temperature or blood count; but other than that, he was very convincing. His abdomen was guarded at just the right times ... He was very good. The Captain seemed genuinely concerned and we went through how we would have to evacuate him ...

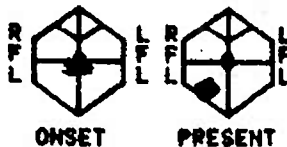
CO/XO: I played it straight. Doc said it might be appendicitis. I said, "OK," and I told the XO to get the navigator ... I guess maybe Doc was convinced I thought it was real.

Submarine #3: Corpsman: First let me say that before we even left, I knew there'd be fake patients. Somebody accidentally spilled the beans. But this says something about your training [of the simulated patients]: when the day came that we had the patient show up ... I discounted the possibility. I did not think he was part of the test.

CO/XO: I think [the patient simulation] was a valid test of the computer and was approached honestly ... the [simulated] case did not come off as a test; the Doc really believed it was real.

PAIN

SITE:



TYPE OF PAIN: INTERMITTENT STEADY COLICKY
SEVERITY: MODERATE/SEVERE
PROGRESS: BETTER/ SAME WORSE
DURATION: <12h 12-24h/24-48h/48+h

AGGRAVATING FACTORS: MOVEMENT ROUGH BREATHING/FOOD/OTHER NONE

RELIEVING FACTORS: LYING STILL/VOMITING/ANTACIDS/FOOD/OTHER NONE

OTHER SYMPTOMS

NAUSEA: YES/NO

VOMITING: YES/NO

APPETITE: DECREASED NORMAL

JAUNDICE: YES/NO

BOWELS: NORMAL/CONSTIPATED/DIARRHEA/BLOOD IN STOOL/MUCUS IN STOOL

URINATION: NORMAL FREQUENCY/PAINFUL/DARK URINE/BLOOD IN URINE

PAST HISTORY

PREVIOUS INDIGESTION: YES/NO

PREVIOUS SIMILAR PAIN: YES/NO

PREVIOUS SURGERY: YES/NO

PREVIOUS ILLNESSES: YES/NO (Comment on pertinent on back)

TAKING MEDICATIONS: YES/NO

(Physical Exam on next sheet)

FIGURE 1. Data sheet for history completed by Corpsman. Actual case of appendicitis.

VITAL SIGNS TEMP-99.2 PULSE- 72 BP- 130/80 RESP- 16

GENERAL EXAM

MOOD: NORMAL/DISTRESSED/ANXIOUS

COLOR: NORMAL/PALB/FLUSHED/JAUNDICED/CYANOTIC

ABDOMINAL EXAM

INSPECTION: NORMAL/VISIBLE PERISTALSIS/DECREASED ABDOMINAL MOVEMENT

BOWEL SOUNDS: NORMAL/DECREASED OR ABSENT/HYPERACTIVE

SCARS: YES/NO DISTENTION: YES/NO

REBOUND: YES/NO GUARDING: YES/NO

RIGIDITY: YES/NO MASSES: YES/NO

MURPHY'S SIGN: PRESENT/ABSENT

RECTAL EXAM: NORMAL/MASS FELT/GUAIAC TEST FOR BLOOD POSITIVE

TENDERNESS- ON LEFT/ON RIGHT/GENERAL



LAB TESTS

HEMATOCRIT- N.E.

WHITE CELL COUNT- 25,650

URINALYSIS (Routine and Microscopic)- N.E.

FIGURE 2. Data sheet for physical examination completed by Corpsman. Actual case of appendicitis.

PATIENT SSN:

TIME/DATE ENTERED:

SYMPTOMS

MALE
AGE 28-29
ONSET CENTRAL
PAIN NOW RLO
COUGHING AGGRAVATES
NOTHING RELIEVES
PAIN NOW WORSE
DURATION <12 HRS
PAIN STEADY
PAIN IS MODERATE
NAUSEA PRESENT
VOMITING PRESENT
APPETITE NORMAL
NO PREV. INDIGESTION
NO JAUNDICE
BOWELS NORMAL
URINATION NORMAL
NO PREV. SIM. PAIN
NO PREV. ABD. SURG.

NOT TAKING MEDS
MOOD NORMAL
COLOR PALE
ABD MOVEMENT NORMAL
NO ABD SCARS PRESENT
NO ABD DISTENTION
TENDERNESS RLO
REBOUND PRESENT
NO GUARDING
NO RIGIDITY
NO ABD MASSES
MURPHY'S NEGATIVE
DECREASED BOWEL SNDS
RECTAL - NORMAL

APPEND	DIVERT	PERFDU	NONSAP	CHOLE	SMBOS	RCOLIC	DYSP
96.58	0.00	0.00	3.42	0.00	0.00	0.00	0.00

To make copy type COPY (RETURN). Key RETURN to continue.

FIGURE 3. Computer display summarizing data entered from data sheets of Figures 1 and 2. Diagnostic probabilities are shown as a percentage. Computer "diagnosis" in this case favored appendicitis. This patient was evacuated for appendicitis from a patrolling FBM submarine.

STRONGLY SUGGESTIVE

Recommend you treat as presumed ACUTE APPENDICITIS---

If you agree with this diagnosis, consider the following:

1. Prepare for probable evacuation (mission permitting).
2. Keep patient NPO; begin IV fluids and antibiotics; start N-G suction.
3. Go to Intensive Care program (ABIC) for more detailed help on patient management.

For HARDCOPY enter COPY. Key RETURN to continue.

FIGURE 4. Computer's diagnosis statement and initial recommendation. Language is designed to allow corpsman flexibility in considering his options.

Submarine #4: Corpsman: I had B come down with appendicitis and then they finally told me it was a drill ... I thought he really had appendicitis ... I was fixing to draw blood when they started laughing so that I stopped that. B got up ... and said, "That's enough, I quit." I was completely surprised ... He was classic [appendicitis] and he was a great actor ... I never associated any of the [simulated] patients with a drill.

CO/XO: [No excerpt.]

Conclusion #2: Positive influence on Corpsman's role and on interactions with his CO and XO.

Submarine #1: Corpsman: If anybody came to me with a problem, I always just broke out these [computer data sheets] automatically. I found the data sheet good to go by for doing the exam; you don't forget things. So I used them ... I'd take [the computer results] into my CO and he'd just turn it over. He wouldn't even consider that until after he'd thought about everything. Then he'd look at the computer printout. [In response to question about whether the CO or XO used the computer results in a real case of appendicitis, later MEDEVAC'd.] No, I don't think so. One of the reasons that they probably weren't so interested in the computer was the old trial by fire. I've had a lot of problems that I've seemed to gotten through and done the right thing and they were pretty confident in me. And that's probably why they didn't put so much reliability on the computer. I think that the computer can hurt a guy, though. Like if it was 180 out of what the Corpsman was saying, the CO and XO should have

a lot of faith in their corpsman vice having a lot of faith in the computer because there's just too many things that a computer just doesn't think about ...

CO/XO: I like the list of symptoms. It was a great overall view that you could look at and say, "This is what he thinks it is," and give it consideration ... We looked at that and said that these are the things that have gone into making the diagnosis. You get a good feeling for whether Doc has taken everything into account.

Submarine #2: Corpsman: [The computer's] confirmation of my diagnosis ... made me feel a little better really ... If it had come up with something else, I would have gone back and reevaluated everything. [I would] rephrase questions to see if I was leading [the patient] or if he didn't know what I meant when I asked the question. The CO said he'd probably go with what I said. I said, "What if the computer said I was wrong?" He said, "Well, I would probably still go with what you said ..." The general feeling I got was that my CO and XO would probably back whatever I said, whatever I suggested. I think they like [the computer].

CO/XO: It appeared to me that he was [initially] leaning toward MEDEVAC [of the simulated patient] because so many things indicated appendicitis. I said, "Well, how about that program we brought along?" He said, "I've tried that, and that's the other thing that's really leading me. I've got sort of a confirmation from it." And I could tell he was trying to be sure that the machine wasn't running the decision ... I don't think he let the computer program sway him, but I'm sure he

felt good there was something else there confirming his diagnosis. CO: I think the real quandry [is when the computer does not confirm the Corpsman's diagnosis] ... That becomes a problem for the Captain ... It is a question of knowing who my corpsman is and his capabilities ... If he said it was not appendicitis ... I think I'd go with the corpsman ... because I think my corpsman is capable of making a valid diagnosis. [In a situation where I had less confidence in my corpsman] I'd sit down with him and I'd go through step-by-step what he put into the computer to find out why the computer says it's appendicitis and he says it isn't: what is he looking at that the computer is not looking at. In that situation, it would cause me to question the corpsman's diagnosis and could have me telling him to go back and inspect again, be more thorough ... I've had corpsmen explain things to me and while they're doing that they realize they missed this or added that ... Whether [this kind of interaction] is positive, negative, or neutral depends on how you handle it ... You can use it as a learning situation ... then it can be of benefit.

Submarine #3: Corpsman:
[Using the data sheet during the examination] ensures you don't leave anything out. [My reaction to having the computer on board] is more favorable now than when we were talking about it 3 or 4 months ago. I didn't really know my CO and XO before. I know them much better now. I feel more comfortable going to sea with them and the computer. Before, I was afraid the situation

might arise where you'd have some sort of Attila the Hun sitting there and you'd go in and he'd say, "Well, let me see the printout," and he'd say, "By God, the printout says that and that's what it is. There's no sense discussing it. We'll do it that way." But that didn't happen and my impression of the Captain and XO now is that it wouldn't happen.

CO/XO: XO: My impression was that [Doc] went to use the program because he wanted to compare that to his own ideas and when he presented the whole thing to the Captain, the program gave him more confidence in what he had diagnosed himself.

CO: I believe the corpsman was independent in his judgment as opposed to putting too much trust in the computer. I feel confident [the program] gave good, practical statistical data to reinforce the corpsman's own opinion. The corpsman's my expert. I expect him to give me his analysis and then [the computer printout] either agrees or doesn't agree with him.

Submarine #4: Corpsman: If the CO and XO don't like a particular corpsman they might say, "Tell me what the computer says; I don't care what you say." But most of the Corpsmen in the fleet now are good, and when you're out there under water anything that'll help back you up fast like this would be great. It takes you 10 hours to hunt and research through all the books to get all the information you can get in 15 minutes with the computer. So it's good just so long as the CO and XO don't start believing the computer over the corpsman. So far as liking it: I loved it. I liked [the printout of symptoms and diagnostic probabilities]

because then I could go back with something in black and white to the old man and XO. If you can show it that way - well, my experience with line officers is they love it ... If you can show them [those probabilities], they're going to like it.

CO/XO: CO: Well, this is my first patrol, but from the way I treated my previous corpsman I'd say [having the computer and programs] did change [my relationship with my corpsman]. It was something to plug in all the symptoms and see what it said. If it agreed with Doc, that was great. If there was some disagreement, we sat down and went over the reasons why he was leaning toward the second probability in the program and [in this case] I agreed with what he said.

XO: If that computer hadn't been there, I would have wanted him to do one thing that I didn't really do this time. [On a previous patrol there was a case that] seemed difficult to pin down symptoms and ... Doc and I went through various books trying to find information that would help make the decision. In these cases [during the trials], I felt comfortable with the computer's information and beyond one or two books, we didn't dig that far. Maybe that's bad, I don't know, but I felt more satisfied with the information given by the computer.

Conclusion #3: The system was useful in making diagnosis or MEDEVAC decisions.

Submarine #1: Corpsman: I probably had a poor attitude towards the computer in the first place. I'm one of those people that believes a whole lot in

myself and not a whole lot in computers. I think computers can be great. It makes me cover everything and it may reinforce me ... I think the computer is viable; it certainly could help some people, knowing the people that are on the boats. I think a young second class [Corpsman] coming out of [Naval Undersea Medical Institute] that really doesn't have much experience would probably benefit from the computer ... [Given the choice between taking the computer to sea or not] I would definitely take it.

CO/XO: I'd like to have it at sea with me because it's another data facet. The most difficult decision I have to make is a medical decision because I'm not trained and my corpsman is not a physician ... I feel that [the computer] is a confirmation tool for standard diagnostic techniques. It's just another indicator and a very important one. For that reason alone, I think it's certainly worth it.

Submarine #2: Corpsman: My feelings on the whole thing is [that] I really enjoyed it. I liked the tapes.

CO/XO: I think that [the computer probabilities] would help dispel any second thoughts I had about whether I should MEDEVAC a patient or not. [The corpsman's and the computer's recommendations provide] two pseudo-independent checks that he's got it.

Submarine #3: Corpsman: Because you did such a fine job of training the patient, I was so concerned that I would have asked Jack the Ripper for his opinion. [The computer] was just another source of information, so it was nice that it was

there ...

CO/XO: CO: The corpsman is our medical expert and we hang a lot on what he says. If there is some other way to look at the symptoms and what they mean, then that's helpful to us. We need to know what the alternatives are and too many times we haven't known [them] and we'd lock onto something ... We already have the computer [aboard] ... the program doesn't take up any room. We've got only one expert in the medical field. The machine provides ... something for the corpsman to compare with. If it's going to be useful to me in my decision-making process, I'd want it with me when I'm out there by myself.

Submarine #4: Corpsman: I want to take [these programs] to sea with me ... [When other corpsmen asked me about the programs I said] I was very receptive. I told them it should be put out in the fleet ... They were like I was when I first started: is the CO going to believe me or this damn computer? After these trials, I'd like it out there. It gives you something to fall back to.

CO/XO: I think [the computer and programs are] a worthwhile aid. If the corpsman is agreeing with the computer and there's only a couple of things you want to check out it cuts down on the work of going through the books. One of the reasons you do that ... is to make sure the corpsman had looked at everything and ... hadn't missed anything while reading through those thick tomes. It gives him a chance to explain his reasoning; and a corpsman ought to have a very good and

logical approach to the problem.

4. DISCUSSION

Interpretation of diagnostic probabilities proved to be a recurrent problem. The corpsmen, XO's and CO's tended to view the diagnostic probabilities as they might view the likelihood of rain given in a weather forecast: while an impression is obtained, a distinction between "rainy" and "not rainy" (as appendicitis vs NSAP) is not clearly made.

Interpretation of this category should be explicitly stated in the program and during training. Without well-defined criteria, interpretation of probabilities was subjective and thus vulnerable to differences of interpretation among the users. During clinical trials at NRMC, San Diego, we had used the criteria of deDombal and his colleagues at Leeds: any disease probability over 50% indicates that diagnosis; if no probability exceeds 50%, diagnosis of non-specific abdominal pain is indicated (6). While useful in the hospital setting, these criteria may need to be redefined for operational use, and thus were not imposed as part of these trials. Raising or lowering the 50% diagnostic threshold will alter the sensitivity and specificity of this diagnostic test (providing another means to adapt the program to meet the requirements of a patrolling submarine). Prior to implementation of these programs, threshold probability limits must be established and corpsmen, XO's and CO's must all be trained to interpret the diagnostic probabilities in those terms.

displayed a more relaxed attitude with the non-specific abdominal pain category. This category included such disorders as irritable bowel, constipation, stress, or spasm of the functional GI disorders; i.e., conditions that do not require surgery and are likely to resolve with little or no intervention. For an inexperienced corpsman, all of these disorders fall into the specific category where the computer was not able to make a diagnosis and thus was of no help.

In debriefings (see Appendices A and B), three of four corpsmen showed an initial defensiveness, over-assertion, or relying on the computer program. In all cases, this initial reaction decreased as the men gained experience with the simulated cases. However, different attitudes and styles of using the computer evolved. Corpsman 1 maintained that for an experienced corpsman like him, the computer was useful only in corroborating his independently made decisions. However, he conceded that a corpsman with less experience or one returning to submarines after a shore duty tour (as he would in 3 years) might benefit greatly. Corpsman 2, who was a very experienced and confident corpsman making his last of twelve patrols, felt the computer to be of value as an aid in gathering data and as an on-board medical consultant. Corpsman 3 felt quite defensive initially, perhaps in part because he was new aboard his ship. His initial defensiveness changed to the point that he expected the computer to consistently agree with him. Corpsman 4 was also resistant to having the computer

initially, but with experience became enthusiastic. He very much wanted the program for use at sea and intended to continue using the data sheets as an aid in evaluating his patients with abdominal pain. However, he saw a possible danger in this with respect to his reliance on the computer exclusively.

Another question addressed in this study was whether having the computer on board affected interaction between the corpsman and his superiors. The computer could be used by the CO and XO to check the corpsman's thoroughness, organization, and logic in dealing with acute illness. Whether this activity has a positive or negative effect on corpsman performance depends on the way the information is used. An overly defensive attitude on the part of the corpsman or an overly critical or judgmental attitude on the part of his superiors could have a distinctly negative effect. This could adversely affect patient management as well as discourage use of the system. It was thus encouraging to hear all XO's and CO's stress that the corpsman, not the computer, was his major source for medical advice. The computer was seen as another information source, and facilitating communication by presenting well-defined medical information in a logical and well-organized manner: the computer provides for more meaningful discussion between the corpsman and his superiors regarding proper handling of the patient.

A final answer to these questions depends on further operational experience with the system. However, an attitude of open-minded skepticism on the part of the corpsmen and

their superiors is a correct one in our opinion, and this attitude was present in nearly all participants. In training the corpsmen and in briefing CO's and XO's, the view that the computer is another clinical tool must be emphasized. Also, clearly establishing the accuracy of the computer programs in the operational setting is important: knowledge of past performance may give users objective measures of how much confidence to place in the computer's recommendations. This is an important goal in the next phase of this research.

The actual cases of appendicitis and NSAP considered in Appendix C illustrate the above discussion. Both cases were evaluated by corpsman 1, who, in the opinion of his superiors, is capable, experienced, and reliable. The first patient, though seriously ill with appendicitis, posed no major decision problems since his presentation of his condition was straightforward. The decision to evacuate was clearly appropriate for the patient and not in conflict with the submarine's mission at that time. According to corpsman 1, the computer played little, if any, direct role in making his diagnosis, but did give him greater confidence in his diagnosis. He was disturbed that the probability was only 94% since he was "100% certain", and voiced this concern to his Captain. He used the computer printouts in his discussions with his XO and CO but felt the printouts did not contribute to the discussion. The CO, on the other hand, felt that the computer printout was valuable in organizing and summarizing the situation, and provided a basis for discussion. The second patient

had abdominal pain so severe that the corpsman administered a narcotic analgesic on one occasion. The corpsman's initial diagnosis was "possible small bowel obstruction", a condition which could require surgery and thus a MEDEVAC. The computer indicated a very high probability of non-specific (i.e. non-surgical) abdominal pain, which could be treated aboard. Though the question of possible evacuation was considered by the corpsman, he, together with his CO, decided to observe and treat the patient aboard. The corpsman in this case felt that the computer program aided in organizing his examination but was of no help in making a diagnosis, in spite of the clear indication of non-specific abdominal pain. The CO, however, stated during the debriefing that the computer's non-specific pain diagnosis aided in the decision to keep the patient aboard and observe him. The patient's condition resolved in several days under careful observation by the corpsman and attention to diet.

All participants found the abdominal pain program acceptable and of help in making medical decisions, especially those involving questions of MEDEVAC. In addition, they recommended expansion of the project so that more types of conditions be covered and in greater depth. For example, they felt programs dealing with acute chest pain and neuro-psychiatric disorders would be of benefit. More specifically, the majority of participants felt that the computer could help in the management of acute abdominal pain patients by making specific recommendations regarding use of drugs and dosages, IVs, monitoring, and that the present care recommendations were superficial and did not really

help. A set of programs to aid in treatment of patients with acute abdominal pain is currently being developed at NSMRL. In addition, programs for diagnosis, prognosis, and treatment of patients with acute chest pain are undergoing clinical tests at this time.

There were no significant problems with the corpsmen's gaining access to or using the computer. It was always available when needed, though its location sometimes made its use awkward. Obtaining readable hard copies of computer displays was a significant problem. Difficulties with the 4631 Hard Copy Unit have been widely experienced throughout the submarine fleet. Although complete failure of the unit is infrequent, correct adjustment of controls has been a problem. The most common cause of murky or illegible copies is use of paper that has exceeded its rather brief 6-month shelf life. Training the corpsmen in adjustment of the copy unit will solve the former problem, and provision of sheets and forms on which to copy computer probabilities and recommendations should accomodate complete failure of the copy unit. Paper taken on patrol must be less than 4 months old and be stored in a cool location.

Finally, although debriefings proved a valuable method for getting data in this study, they are too time-consuming to be used in fleet-wide trials of the system. Further, the data are subjective, possibly biased by the questioners, and are not amenable to statistical analysis and use with data processing tools.

5. CONCLUSIONS

In four FBM submarine patrols, four corpsmen, four XO's and four CO's evaluated or decided disposition of nine simulated and four actual cases of abdominal pain. These cases provided an adequate test of user acceptance of a computer-based system for diagnosis of acute abdominal pain. At the end of the trials, all corpsman and all XO's and CO's indicated the system was acceptable and was useful in making diagnosis and MEDEVAC decisions. They were also in favor of its use aboard submarines. The officers felt the computer programs were valuable in organizing and summarizing the situation, and provided a basis for discussing the case with their corpsman. The corpsmen stated that they regarded the computer as an aid to, rather than a replacement for, their clinical judgment and that the computer was especially helpful in organizing and ensuring completeness while evaluating patients. Although this study was not designed as a clinical trial, all actual cases of abdominal pain were "diagnosed" correctly by the computer.

These results support the conducting of extended, controlled clinical trials of the computer and its programs during operational use. However, the present study indicates the following recommendations.

1. Improve interpretation of computer-generated diagnostic probabilities.

- a) Apply decision theory to determine optimal threshold diagnostic probability for optimal balance between under-diagnosis and over-diagnosis.

b) Teach how to interpret the diagnostic probabilities.

c) Investigate alternative methods for presenting results, e.g., give "diagnosis" rather than probabilities list.

2. Modify training of corpsmen and XO's and CO's.

a) Shorten the training of corpsmen to 12-14 hours; expand the briefing of XO's and CO's to accommodate the recommendations contained here.

b) Discuss the meaning and possible consequences of various diagnoses; particularly, define "non-specific abdominal pain" and distinguish disease categories which are serious and might require evacuation.

c) Continue to emphasize viewing the computer as an aid to making medical decisions, rather than as a replacement for the corpsman or his clinical judgment.

d) Further emphasize use of computer and outputs to improve communication between corpsman and his superiors in making medical decisions.

3. Compensate for deficiencies in obtaining hard copies of computer displays.

a) Train corpsmen in use and adjustment of hard copy unit.

b) Ensure fresh copy paper is provided.

c) Provide copies of history and physical examination datasheets and forms to manually record computer output information.

4. Develop new measures of the performance of the system and users.

a) Objective and subjective data.

b) Amenable to data processing methods and statistical analyses.

6. ACKNOWLEDGEMENTS

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APPENDIX A
EDITED TRANSCRIPTS OF CORPSMEN DEBRIEFINGS

EDITED TRANSCRIPT
DEBRIEFING OF CORPSMAN 1

Q: How many cases did you use the abdominal pain program on?

A: Six.

Q: How many of them were real cases?

A: Three.

Q: Tell us what happened.

A: I went through a normal refit. I had no simulated cases during my refit period or during my sea trials. Then we started on patrol.

Q: Did you know there were going to be some simulated cases?

A: No. I got into patrol and had my first simulated case, then I had several real cases, one of which led to a MEDEVAC, and then two simulated cases at the end. I think the command held up my simulated cases because my real case load was tremendous.

Q: For each case, could you tell us what happened, from what the ship was doing right up to the decision to stop everything. Also, indicate if it's a real case or a simulated one.

A: The first one I have is a simulated case. He came to me with what I diagnosed as non-specific abdominal pain or gastroenteritis. I didn't have any data sheets and the printer was not working. I just went by the definitions sheet, went straight down it and it covered all the topics that I needed to cover. In fact, it had every question and every block and how to fill it out. On every one of my patients I did a full examination including the rectal exam. I approached the Executive Officer on the second day of the first patient's illness and asked him if there was a reason why he would be faking. I had decided that he was doing some movements that he should not be able to do without causing a lot of pain on himself.

Q: You mean you observed him around the ship?

A: Well, I think it was more during the exam. He was trying to reach the stereo system while he was laying down and it just wasn't right and then when I did my further exam on him, I would press on him where it was supposed to hurt and he wouldn't hurt there if he wasn't expecting it. So that's why I thought he probably was not a real case.

Q: Was this your initial exam that you suspected this?

A: No, it was my re-exam. I do re-exams on patients fairly frequently.

Q: Tell us what was happening in the ship's routine.

A: We were on patrol. I was playing cards in lower level OPS when he came down to get me. It was 1300. I left my card game to see him because he's not a person that would normally come to see me or bother me with a problem. So I went up to my office and did the normal vital signs, laid him down, and then looked for the data sheets and stuff. If anybody came to me with a problem, I always just broke out these papers automatically. I didn't even wait to get into the story because I figured there was no sense having to write it twice. I found the data sheet pretty good to go by for doing the exam; you don't forget things. So I used them. I saw him for two days and I placed him on bed rest and observation.

Q: The initial exam, how did that go?

A: I didn't find anything really striking about the patient; the computer diagnosis was dyspepsia and I had gastroenteritis. The second time through it came out more non-specific abdominal pain. They were done right together so I diagnosed him as gastroenteritis because he just did not have anything striking, just a pain, and it followed a fairly normal onset. You know, it did start centrally and move to the right lower quadrant, but I place a lot of emphasis when I look at some-

body that has possible appendicitis on vital signs, mainly temperature, and white count, and the computer doesn't take into account those two things. One of the things I disagreed with most about the computer the whole time was that it didn't take in those two things. I think that anybody who has an acute abdomen is going to have a white count elevation and they're probably going to have a low-grade fever. Even with something as mild as dyspepsia they probably would.

Q: Did you do a white count on him?

A: Yes.

Q: Did you happen to do a differential as well?

A: Yes, I did. After my first go through with him. I always put a patient on bed rest and observation and I don't normally make a diagnosis on somebody. That's one of the things I found difficult later: if you see somebody you might have an idea but you don't really know what they have the first time you see them. I do a re-exam, which is very important 4 hours or 12 hours later.

Q: Did you go to the computer between the first and second exam?

A: I think, probably, I did.

Q: Do you think having that initial reader [computer] printout had any influence on your second exam of the patient?

A: Yes, it had significance because I had a list of symptoms to work with, but other than that, no.

Q: But you had a "diagnosis" as you approached him the second time. Do you think that influenced your exam or what you thought about your patient?

A: Yes, I think it probably did. With what I found on my initial exam and what I thought the patient had, it probably did influence me.

Q: Do you think it's a good or bad thing that you were maybe a little biased, if that's the case, by the computer?

A: It would probably be bad because you'd tend to put in what you think the computer's going to spit out.

Q: Did the initial use of the computer reinforce what you thought or did it help at all at that point?

A: I probably had a poor attitude towards the computer in the first place. I'm one of those people that believes a whole lot in myself and not a whole lot in computers. I think that computers can be great. It makes me cover everything and it may reinforce me, but I certainly would not use it if it disagreed with me significantly. I would probably try to keep it away from my XO and CO.

Q: You would try to keep it away from them?

A: I probably would, but I never came to that problem. One guy had gastroenteritis. I thought he did and the computer said 90+% chance that he had appendicitis. I just went in and I told my XO and CO quite frankly, this guy doesn't have it. They kind of always went along with what I said. Of course, when it's a simulated case, it makes a lot of difference because they knew he was simulated and I didn't.

Q: We'd like to get a feeling for what happened and how the CO and XO got into it.

A: I usually approach the XO right after I see the patient. I'll go in and I'll just tell him that I have somebody that has a problem and what it is. With the first patient he just said, "Did you use the computer on him?", and I said, "No, but I've got all the information to put

him into the computer." The questionnaire asked if the availability of a computer printout strengthened or weakened my argument. Most of the time I put neither because I'd take it into my CO and he'd just turn it over. He wouldn't even consider that until after he'd thought about everything, then he'd look at the computer printout. On the first case, I thought it strengthened; he was my first one. I probably had better vibes about the computer with my first patient than I did on any of the rest. Then the questionnaire says, "Do you think the decision relating to the management of this patient would have been different had the computer not been used," and I put "No." Then it says explain your answer below, and I put, "My command has generally trusted my judgment on these matters and followed my recommendations," which they did with all patients - kind of listened to what I had to say."

My second patient was my MEDEVAC, real, not simulated. I kept him three days before I got rid of him. I had trouble with IV's and stuff but the diagnosis was straightforward.

Q: How was your schedule affected by his being ill?

A: Dramatically. When there's only one corpsman, there's not a whole lot of choice. Anyway, I think the computer is viable; it certainly could help some people, knowing the people that are on the boats. I think a young second class corpsman coming out of NUMI that really doesn't have much experience would probably benefit from the computer.

Q: This is probably a question I should save for the end, but given a choice between having it and not having it, which would you choose?

A: I would definitely take it.

Q: How accessible was it to you?

A: At the beginning, it wasn't very accessible, but, you know, rank has it's privileges. When I wanted it, it got moved to control fairly rapidly.

Q: So you would take it with you, and it would be more useful if it could be more accessible to you?

A: Right.

Q: When you first saw the [MEDEVAC'd] appendicitis patient, did you use the data sheet in evaluating him?

A: Yes.

Q: Was that helpful?

A: Yes.

Q: In terms of your approach, do you think it was any different as a result of the training you had received, having the data sheet, and having the computer there?

A: I think the thing that helped me most is probably just the training that I received - just kind of a review.

Q: Supposing that this was 3 years from now and you had not had any training for this period of time, how would you react to having the computer especially for refresher training?

A: I think it would be very useful.

Q: How many times, altogether, would you say you used the computer?

A: Well, I probably used it 20 times.

Q: How do you think that you'd react to the computer a year or so from now if you had it on board constantly? Do you think you'd still be using it?

A: Well, I think I'd probably still use it, yes.

Q: I'd like to stick with this case, the appendicitis, a little bit more since

it's a good chance to talk about a real case with this computer at sea. You had the data sheets, you gathered the data according to the data sheets, and you added what you normally do that wasn't on the datasheets: white count, differential, vital signs. Then you came up with your own opinion that the patient had appendicitis. Then you went to the computer?

A: Yes.

Q: And you entered all the symptoms and you came up with a diagnosis where the computer pretty much agreed with your assessment.

A: Right. I did feel a little funny when it typed out 91% or something. I thought that was bad or something. I said, "Hey, this machine's got to be more confident than that." I'm more sure than that and this machine's got to be more logical than me and it wasn't. That kind of bothered me, you know.

Q: So you felt like it ought to be more confident than that because you were more confident about the diagnosis. Did you go to the CO at that point?

A: I went to the XO first and then I went to the CO after I got the print-out and showed him.

Q: Did the XO mention the computer at all as you were talking to him?

A: I can't remember whether he did the first time. No, I don't think he did. I think that in the course of the conversation I just mentioned that I was going to use the computer to see what it spit out.

Q: Supposing that the computer had said something like 60% probability of appendicitis and 40% probability of something else. Now the question is how would you have reacted to that?

A: I probably would have done the same thing I did except that the CO would have had the harder decision of whether he believed the computer over me. It wouldn't have changed my diagnosis at all. It would not have changed my opinion, my diagnosis or anything about this patient. I'm sure of that.

Q: Did the CO or XO seem like they were interested in the computer answer? I mean, did it seem to make any difference to them that they had it in that situation?

A: No. I don't think so. I tell you, one of the reasons that they probably weren't so interested in the computer was the old trial by fire. I've had a lot of problems that I've seemed to have gotten through and done the right thing and they were pretty confident in me. And that's why they probably didn't put so much reliability on the computer. I think that the computer can hurt a guy, though. Like if it was 180 out of what the corpsman was saying the CO and XO should have a lot of faith in their corpsman vice having a lot of faith in the computer because there's just too many things that a computer doesn't think about.

Q: Was the computer useful?

A: I think I could have been heavier on the computer. I think I got a lot heavier on it than I intended to when I left because I had to. I didn't know that much about the computer but you know I can break right into it now. One of the things I don't like is the way you type in all the symptoms on a guy and then, if you make a copy, you lose what you have in it. It goes right off and you can't recapture it unless you put it all back into the computer again.

Q: On a scale of "It's terrible" to "Wildly enthusiastic" where do you think you'd fit in terms of having the computer here when you get back from your shore duty?

A: I think I'd welcome it. I think it'd probably help me out more. It would be

a useful tool.

EDITED TRANSCRIPT
DEBRIEFING OF CORPSMAN 2

Q: You say you had just one case, a simulated one. Tell us the whole story from beginning to end.

A: All right. We had just completed evening drill, 1900. I was sitting back in my office and the Chief came in. He asked me if at the end of the drill he could see me back in the office. He was having a problem.

Q: Did you have any suspicions that he was faking?

A: I had absolutely no suspicions. None.

Q: You didn't know that you were going to get a fake case?

A: Right. I didn't know. He came back and I said, "What's the problem?" He said, "I've got some pains in my abdomen." He looked ... you know, it just now dawned on me that it was because of the drill ... he was a little sweaty. He said it started earlier this morning but he just thought it was indigestion. Now it just kind of hurts mostly down here. I broke out a pad of paper first and started writing a couple of things down: where the pain was; how severe it was; where it is now. I said, "Just a minute, Jim. If you don't mind, I'm going to break out my computer paper," and he said "O.K." So I broke everything out. I couldn't get a good copy off of my printer so I kept the data sheet that you guys gave me to begin with. I just wrote everything down on a piece of paper. I just started asking questions, just following down the data sheet. I said, "Well, it kind of sounds like it might be appendicitis." I took his temperature [he had been drinking coffee during the drill trying to get the temperature in his mouth up] and by the

time I took it, his temperature was back down to normal. Then I laid him down, you know, helped him up on the table. You know how big Jim is and what kind of work space we have to work with. I wrestled him up on the table and bared his abdomen and started the physical on him. I listened for over 5 minutes and decided that he had normal bowel sounds. Then I started palpating him and he said that it hurt. I pushed in the upper area; he said he could feel some pain down in the lower area. The first time I examined him, he had generalized right lower quadrant pain with no rebound. I started scratching my head. I did a rectal on him. He had some right sided tenderness. I said, "Well, it sounds like you might possibly have it, but let's just hold off for a little bit and I'll see you in about an hour and a half or so. Just go sit down and relax in the quarters and I would prefer it if you didn't drink anything. If you do, maybe just a few sips of water." When I left him, I went up and ran it through the computer.

Q: You did run it through the computer?

A: Yes, before I talked to the XO. Computer says about 74% chance of appendicitis; possible early presentation of acute appendicitis. I told the XO, "I kind of agree. Rebound is not there and the temperature is not elevated and he hasn't had any nausea or vomiting yet but the possibility is there. I just want to let you know. I'm going to recheck him at about 10 o'clock tonight." He said, "O.K." So I went down and I just checked on him a couple of times, went back to my office and did a couple of other things, broke out my microscope and everything else and when he came back I did another complete exam on him and rebound still hadn't shown itself. So I said, "I'm going to draw a blood sample on you." He said, "O.K." So I drew blood on him and he peed in the bottle for me. I did a white count first and I came up with 60, 70, and 71 hundred, and then I did the differential. I don't have a little counter thing so I just write down on a

piece of paper. I came up with a normal differential.

Q: Did you take his temperature?

A: I took his temperature and it was still normal. So I went back to the computer and ran it through and I came up with a 79%. I went back to the Captain and the XO and I said, "Well, I'm going to watch him for another 2 hours." I also said, "Where are we?" I went back to sick-bay and I started working out my treatment schedules; how I was going to treat him; what I was going to treat him with. Then he came back and he stood at the door like this and he says, "Hey, Doc", and I looked at him and he said, "Do the initials NSMRL mean anything to you?" I looked at him and I said, "Post" and he says, "Uh-huh", and I says, "Agh!" The CO and XO knew this was going to happen but they didn't know when, either. All they knew was that F__ would tell them the day he was going to do it and that's all he did. So I didn't know if he was the only one or if there were going to be others. When we pulled in here I saw you, you said there should have been two more. One guy we left behind and, I guess, the other guy just kind of chickened out.

Q: How did you feel about all this?

A: It was very interesting. My feelings on the whole thing are I really enjoyed it. I liked the tapes. The training tapes were very good. It took me a while to realize that you had to upper case on a couple of things instead of lower case to get the information out but I enjoyed it. If you want to test me on anything else, I'd gladly do it. I didn't feel the least bit slighted or anything.

Q: You didn't feel we were tricking you or anything?

A: No, I didn't feel that way at all about it.

Q: You understand why we had to do that?

A: Yes. F__ explained that you brought him up to the hospital and had him run through it a couple of times and he said his wife didn't appreciate it because it was just before we left. He enjoyed it, too.

Q: Were there any other real cases that occurred?

A: No, none.

Q: How convincing was F__?

A: He was convincing with one exception: it's hard to duplicate or fake a temperature or a normal blood count. But other than that, he was very convincing. His abdomen was guarded at just the right times, no rigidity and he was very good. My compliments to you guys for training him because he was very convincing. I wouldn't have suspected him of trying to lie to me anyway, being the Protestant lay leader and all that.

Q: How about the accessibility of the computer and so forth. Any problems?

A: No, none.

Q: Where was the computer?

A: Control. The problem is, as you can see, lousy copies. We had trouble the whole run with this. They had the thing apart several times, but as far as access to the computer, a couple of guys were using it for other things; I said, "I need it," and they said, "O.K., Doc," They took their tape out. I might not have been able to use it during a fire control tracking party or something like that.

Q: Did you have any trouble using the data sheet?

A: No. The data sheet is OK but the way it presents on the screen is a little

confusing. I think it would help if you put some more lines in, because it was kind of hard every now and then to look at it and decide what was where. I liked using a number code rather than an abbreviation to enter findings.

Q: If there had been numbers on your data sheet to correspond to it, would that help?

A: You could put down your symptoms and the numbers right along side of it and when you use the computer just plug in the numbers. That would make it faster.

Q: Did you find the training was useful in terms of what we gave you here?

A: Yes, the training was useful, especially getting us familiar with how to use the computer and making sure that we asked everything that you're supposed to ask.

Q: Would you make any suggestions for the training - either add to or delete from?

A: I don't think you need it to be quite as long as it was.

Q: Did you have enough time on using the computer?

A: I think maybe showing us what to ask for when you get a syntax error or how to ask it a question. You know, you also have the people on board who know how to do that. I asked my sonar chief - I said, "Inline error - what do you do?" I think maybe showing us how to do that might be beneficial.

Q: Other than that, did you feel oriented to the computer system?

A: I felt very oriented with it because when we got over to Holy Loch and I had the tapes, I told the corpsman

I was relieving about it and he said, "Good, I've got one I want to run through." He told me the symptoms and I entered them in and he came up with 98% dyspepsia. He said, "Good. That's what I think; he's got an ulcer." I had 2 guys with pain during the refit, when things were hectic. I went up and I just ran them through the computer and they both came up 98% dyspepsia. One guy is all psychosomatic and the other guy probably does have an ulcer.

Q: So you did use it on other patients during the refit?

A: Yes, I did during the refit.

Q: Why did you use it?

A: Just to see what it said.

Q: Just out of curiosity?

A: Yes.

Q: Did you find any benefit from using it at that time?

A: Yes. Confirmation on my diagnosis. It just kind of made me feel a little better really. Now if I had decided that this guy had dyspepsia and it came up with something else, I would have gone, hmm, either it or me is wrong and I would have gone back and re-evaluated everything.

Q: So if nothing else, it would have made you take a second look at things?

A: Yes.

Q: What would you have done in a case like that. Suppose it disagreed with you and continued to disagree.

A: Well, if it had disagreed with me once, I would have gone back and done some more reading, and tried it again. If it really disagreed again, I really don't know what I would have done. I think probably I would have stuck with what

- I thought.
- Q: Would it have caused you to go back to the patient at all?
- A: Yes, and re-phrase questions to see if maybe I wasn't leading him, or if he didn't know exactly what I meant when I asked the question.
- Q: In general, do you see the computer as helping you or hindering you.
- A: Well, it depends on the corpsman.
- Q: What form do you think any help would take?
- A: Keeping you on your toes, because if you come up too many times disagreeing I think then something's wrong somewhere. Either the corpsman isn't paying attention to his patient or needs to be refreshed in an area.
- Q: I'd like to ask about the reaction of the CO and XO.
- A: I asked them after F__ came to us and the CO said he would probably go with whatever I said. I said, "What if the computer said I was wrong?" He said, "Well, I would probably still go with what you said." I said, "How about a corpsman you don't know - first run out." He said, "I would probably still go with him. I might ask him what the computer said and ask him if he thought he was doing everything right." The general feeling I got was that my CO and XO would probably back whatever I said, whatever I suggested.
- Q: Do you have any feeling for how they felt about the computer?
- A: I think they liked it. I think it's a very good thing that you said don't touch that extra tape, because my CO would probably have been out there with the damn thing using it. He likes to get mechanically involved in everything.
- Q: How would you have felt about him coming down and saying, "Would you mind if I ran the tape?"
- A: It wouldn't have bothered me, I don't think. Yeah, it would have. It probably would have bothered me.
- Q: Can you picture an instance where that might happen on a submarine? Where the CO or XO might want to come down and use the machine to get their own answer on a patient?
- A: I suppose it would depend on the particular CO or XO; whether or not he was a med school dropout or something like that. I've known cases where an XO or CO was a pre-med student at one time and thought they knew everything. Those people are around.
- Q: Would it depend on whether you felt he was coming down to double check you or whether he was coming down to play?
- A: Yes. My CO would probably come down to play.
- Q: I'm talking about an instance where you had a real patient, there was really a concern about evacuating him or not, and either the XO or CO says, "I would like to try this myself."
- A: Fine. I'd hand him the data and say go to it. If he's going to put in the same data that I have down, then he would probably come up with the same answer.
- Q: How did they react as far as you were concerned when you said you had a possible appendicitis? Did they react in such a way that you felt was realistic?
- A: They reacted realistically.
- Q: How did they react?

A: The XO said, "Well, what are you going to do?" I said, "Well, I'll probably have to start an IV on him and the next thing I need is a bed." He said, "He can have mine. I'll sleep in his. If we're going to evac him, he'll only be in here a couple of days at the most." The Captain seemed genuinely concerned and we went through how we would have to evacuate him, who we would have to send a message to, and I explained to him that Captain Blankenship would probably agree with my decision.

EDITED TRANSCRIPT
DEBRIEFING OF CORPSMAN 3

Q: How'd it go?

A: It went OK. First of all, let me say that before we even left, I knew there'd be fake patients. Somebody accidentally spilled the beans. But this says something about your training: when the day came that we had the patient show up, I wondered if this was it and then I looked at him and (a) because I felt he was quite reliable, and (b) because you did such a good job of training him, I discounted that possibility. I did not think this was part of the test.

Q: You thought it might be a real case?

A: I definitely did.

Q: In general, how do you feel about using the computer in evaluating patients with acute abdominal pain?

A: Because of the fact that you did such a good job in training the patient, I was so concerned that I would have asked Jack the Ripper for his opinion. It was just another source of information, so it was nice that it was there. It was helpful. It was reassuring because the machine and I came up with the same opinion.

Q: What was your diagnosis on this first one?

A: I think they both were "non-specific abdominal pain."

Q: How do you feel about patient #2 in relation to patient #1. With the second patient, did you have the same reaction or did you feel that this wasn't a real case.

A: No. I felt he was real, too. It was done at the very end of the patrol and I said to myself, "They wouldn't have waited this long." Furthermore, again, this was a guy that I felt was reliable. Isn't it funny - because a guy is reliable, you assume he's not the one who's going to try to trick you. But the whole case just didn't add up to anything. I didn't even use the machine for patient #2. We only went for a few hours and it was just to the observation stage. Since he was busy getting ready to turn over to the next crew, he just said, "There's nothing really wrong with me." So it wasn't much of a test for that patient.

Q: Where was the computer located?

A: In sonar space.

Q: And how difficult was it to access at the time?

A: No difficulty whatsoever.

Q: How about commenting on the interaction with the computer.

A: It went smoothly. No problems whatsoever.

Q: So you only had one patient where you really used the computer and went through the whole thing. When you evaluated patient #2, did you use the form?

A: The form itself? No, I didn't.

Q: OK. Did you use the data sheet with the first patient?

A: With the first patient, yes.

Q: Did you feel that the form in and of itself was useful? For example, did it help you organize your thinking?

A: That's just it. It sort of insures you don't leave anything out.

Q: Did you feel that your training in the use of the whole system was adequate?

A: Yes. I especially think, in retrospect, that spending so much time learning or refreshing ourselves regarding stomach pain was really helpful; that plus the use of the machine was also adequate training.

Q: What kind of an interaction took place between you and the XO and CO in regards to patient #1?

A: The XO was not awakened at the time. The Captain, while this was going on, didn't seem very concerned; he didn't react much. In fact, I sort of admired him for it. I would just keep him informed of what was going on. On day 2 I did speak with the XO, just to keep him informed, too. He didn't seem overly concerned either, which I felt was interesting also.

Q: I'd like to ask you to tell what happened from the time the patient first came to you until he left your care.

A: OK. This may be difficult. He came to me complaining of "abdominal" pain: and he looked ill. He was walking holding his stomach. Initially, I decided, after taking the vital signs, that we would observe for a few hours. After a few hours there was no change.

Q: You did a complete history and physical at that time?

A: No, I didn't. There's so many vague pains and everything, cramps and everything else, that, initially, I wouldn't do anything to anyone unless

they had an elevated temp or something that was really remarkable. If I'm not mistaken, he was under a great deal of pressure at the time, too, as far as his job was concerned and that's probably why I said to myself he's just being overworked.

Q: Did you work him up on the computer at that time or just recommend that he come back and see you.

A: I recommended that he come back and see me after a few hours.

Q: All you did was take vital signs?

A: Probably.

Q: And you said I'm going to wait a couple of hours and see what develops and then go do what's indicated?

A: I eventually became more concerned, and examined him without the questionnaire. Then I became more concerned and told him to lie down and we'd wait longer. I read my various manuals trying to rule things out but still hadn't gone to the computer at this stage. I think I got very angry about using the computer at the time, as a matter of fact. I was real worried he might have something serious, and I said, "Now I suppose I'll have to fill out that damned form and come up with something for them, too." After I settled down a little bit I felt I might as well go check it with the machine also, and see if it can come up with anything significant. I had come up with a diagnosis and I think I was just looking for a confirmation, hoping it was going to come up with the same thing and it did.

Q: Let's get back to the first case. What actually did you say to the CO the first time?

A: I can't remember exactly. Probably it went something like: "I have a patient who's not feeling well; he has abdominal pain. Right now we're sort of just observing. It all adds up to, as I see

it right now, nothing specific; there's something wrong, but I don't really know for sure what it is." I probably reassured him that in my mind it was not what everybody dreads, you know, acute appendicitis.

Q: Did he say anything about the computer at all?

A: I think he said, "Did you use the computer?" I immediately went and got the printout and he looked at it and said to keep him informed.

Q: Did you feel that they were looking over your shoulder or checking up on you?

A: I did not feel that way at the time. In fact, if anything, they seemed a little too nonchalant.

Q: How did you feel about having the printout to support your impression?

A: Well, thank goodness, the computer and I agreed. It was reassuring to be able to say, "By the way, the computer agrees with me."

Q: Had the printout not agreed with you, what would have done with it?

A: That's a very difficult question. If the computer had said, for instance, it was an acute appendicitis, I probably would have considered that and if things didn't get better, I probably would have assumed that it was appendicitis in this specific case.

Q: Would you have changed your diagnosis?

A: To play it safe in that particular case? If the computer came up overwhelmingly indicating that it was appendicitis, I might play it safe and, even if I didn't feel strongly that it was that diagnosis, act upon that diagnosis.

But this probably wouldn't come up often. I would guess that in 99% of

the instances that we use it, the computer would be in agreement with the corpsman.

Q: What do you base that feeling on?

A: Well, most patients have a symptom that just stares you right in the face and when you see that symptom you jump on it and it's sort of hard to steer yourself away from that symptom that's just staring at you - that classic symptom. For example, for acute appendicitis, you know the pain starts here and then travels down there. If you see that, it's hard to be swayed and if you feed that into the machine, it's using the same information.

Q: So you feel that the machine is going to use the information pretty much as you would yourself and that it's going to agree.

A: Yes, it probably will.

Q: In general, what's your reaction to having the computer on board?

A: More favorable now than when we were talking about it 3 or 4 months ago. I didn't really know my CO and XO before. I know them much better now. I feel more comfortable going to sea with them and the computer. Before, I was afraid the situation might arise where you'd have some sort of Attila the Hun sitting there and you'd go in and say, "Well, Captain, I think it's this and he'd say well let me see the printout," and he'd say, "By God! The printout says that and that's what it is. There's no sense discussing it. We will do it that way." But that didn't happen. So I feel, personally, more comfortable with the machine, and, again, it's nice to have it on board.

EDITED TRANSCRIPT
DEBRIEFING OF CORPSMAN 4

Q: Did you have any real cases?

A: I had one real case. Bill gets constipated real easily when he gets nervous and he usually takes Ex-lax for it. He came to me complaining of constipation and I felt a mass, what I thought was a mass, on the lower half of his abdomen consistent with constipation. I gave him two tablets of Dukolax. He'd been constipated for a week. Six hours later he didn't have any relief. I told him to drink some apple juice. The next morning, he was in his rack having severe abdominal cramps. He'd been on the morning watch and been in the head all morning with real bad diarrhea. He had cramps along the lower half of his abdomen. I did an exam on him and I came up with a probable gas build-up in his lower abdomen. Anyway, I followed him. It turns out that he was up all night, the rest of the afternoon and most of the evening with cramps. The computer said he had a 46% chance of appendicitis, 30% NSAP, and 22% small bowel obstruction. This was done the first day right after I gave him the Dukolax.

(Author's note: These probabilities represent a diagnosis of non-specific abdominal pain, which includes constipation.)

Q: What do you think the computer's telling you when it tells you 30% Non-sap and 22% small bowel obstruction?

A: Certainly it could be a good chance of any one of them. The way I read it, the way it printed out, it gave me APPY 46%, NON-SAP 30%, and SMALL BOWEL 22%. It's telling me that of all the cases you put into the computer, with these particular symptoms, 46 had appendicitis, 30 had non-sap, and small bowel had 22.

Q: Did those results help you at all?

A: Not really. On this guy, I kind of

ran him through the computer just because I had an abdominal case.

Q: How did you feel about the results?

A: I didn't agree with it. It was kicking out 46% appy and something about the guy told me that this wasn't an appy case. I felt that he was constipated, which he gets all the time. That's why I treated him the way I did.

Q: Do you think that some other way of presenting the data would be helpful? Maybe adding an interpretation of what the results might mean?

A: No. I liked it. If I felt that it was an appy and the computer kicked out 46% appy and 60% small bowel, I'd still go with appy. I'm receptive to the percentages, I like them. With the numbers there it's very easy to show a line officer. He's going to understand appy - 46, and small bowel - 22; he's going to like that. If you put maybe's in there, it might be confusing.

Q: Did the CO or XO fill out a questionnaire on W?

A: Yes. I don't remember if I did on W. I don't think I did. In fact, I don't think I even ran him through the computer. I copied down all the info but I don't think I ran it on the computer until that afternoon. I know in coming up with the probabilities that I had, I would probably want to put him on NPO or something like that but I don't really remember on this particular guy what I did. I didn't take good enough notes on him. He resolved - no problem.

Q: Tell us about the other cases.

A: Well, I had B come down with appendicitis and then they finally told me that it was a drill - that he was fine. I never associated any of the (simulated) patients with a drill.

Q: OK, B was your first simulated case.

A: Yes, it was 4:30 in the morning. He came to me with right lower abdominal pain and in acute distress. He said the pain had been in his right lower quadrant for 12 hours, started in the umbilical area and moved to the right lower quadrant. There was nausea, vomiting and anorexia. He had normal bowels and urine. During the exam, I heard hyperactive bowel sounds in the left upper quad and the left lower quad, but they were decreased on the right side. I didn't feel any masses. He had slight pain in the right upper quad upon palpation. He had rebound. I called it slight guarding because I wasn't really sure if it was guarding or not. There was no rigidity and the rectal exam was within normal limits. I thought he really had appendicitis. After I examined him, I had the leading cook stand by while I went up and punched the computer. I saw the OD and asked him where are we. Let's turn around, let's head back into port. I woke up the XO and said we're going to have to leave, B's got appendicitis. Everything went fine, we got the CO up. After I woke the XO up, I ran it through the computer, came back and gave it to the XO and CO, who was up at that time. The CO ran it through the computer and it showed 82.9% appendicitis. We moved B to the XO's stateroom and put him to bed and I went back down and got all the IV's together and penicillin and came back up to the stateroom. I was preparing to draw blood when they started laughing - so that stopped it. B got up, tied his shoes, and said, "That's enough, I quit." I was completely surprised. I really thought he was an appy case. And the computer backed me up. The computer said the same thing. He was classic and he was a great actor. They stopped it before I could draw blood or get any urine or anything like that.

Q: How did you feel when you found out

that he really was just a simulation?

A: It was a let down but a total relief.

Q: Did you feel any animosity towards anyone at that stage?

A: There was a quick thought of what the hell's going on. Then I realized they said it was a drill to test the computer and with that I was just relieved that he wasn't a real case.

Q: Could you go into as much detail as possible about your talk with the CO and the XO: what role, if any, the computer results had in that interaction?

A: It's hard to say because, as I look back, the Captain kept asking what does the computer say - on all three cases - and my answer was it just says this but I feel it's this. He kept going back to see if I had actually run it through the computer. The only time the computer really came in was with T. I did several exams on him and it got down to the Captain saying, "What do you think it is and what does the computer say. Give me a diagnosis now." And I couldn't give him one. The computer was giving me too many probabilities right there close together and I had 3 or 4 different diagnoses. It turns out that it was vague anyway. Talking with my Captain about it, he likes the computer because it's an aid for me. He's like I am. Anything that will give me some help - fine.

Q: So at the time that you went to the CO and XO, on all the cases, you thought that you had a real situation.

A: I thought I had a real situation. I didn't think any of them were drills. H is the type of guy that, if he had a problem, acted like I would expect him to act. That's the type of guy he is. You know, it hurts a little bit but it doesn't hurt; it'll go away. T was

just like I believe he would act:
trying to get out of work.

Q: Nobody seemed unnatural to you?

A: No.

Q: Well, given that you thought it was a real situation in every case, could you say how you felt about having the computer printout in your hand? Whether or not it agreed with what you were thinking.

A: I liked it because then I could go back with something in black and white to the CO and the XO. If you can show it that way, well, my experience with line officers is that they love it. I don't know how you are, Dick, but if you can walk up and show him where it says 95% there and 13% there and 2% there and I'm saying its that one there with 95%, they're going to like it.

Q: Well, let's get to T because that sounds like a case where you didn't agree.

A: Five days before we were due to come in, at 8 o'clock in the morning, he came to me complaining of pain in the right lower quadrant. He was reluctant to reveal any info unless prompted by a real direct question. I really had to draw the info out of him. He said the pain started as indigestion 18 hours ago; he took some Maalox and woke up with the pain in the right lower quadrant. Or the lower half of the abdomen, excuse me, which progressed to the right lower quadrant. He said it was steady and had remained the same since awakening. Nothing aggravated it or relieved it. He was nauseated but no vomiting; appetite normal. Bowel movements normal with no changes in stool consistency or color; urination was normal. He had previous indigestion but nothing similar to this. No abdominal surgery. He was in distress, but his color was normal; his abdomen,

everything was normal. Had tenderness in the lower one-half leaning toward the right. On percussion, I got a lot of air sounds in the right lower quad. Sounded like gas. Bowels were hyperactive. Murphy's sign was absent. Rectal was normal. I diagnosed it as a gas bubble in the large intestine. Ruled out appendicitis and ruled out small bowel obstruction. I observed the patient and gave him TYGAN to relieve the nausea. Everytime he saw me he was in pain, but I caught him a couple of times goofing off and obviously not in pain or any distress. This started me thinking. You've got to realize, too, that at 9 o'clock that day we had a 5-hour field day and past history on this guy works into this, too.

Q: Did you use the computer the first time you saw him?

A: Yes, but I didn't write down the results. I started out saying that initial diagnosis is non-specific abdominal pain, ruled out diverticulitis, appendicitis or small bowel obstruction.

Q: Was any computer probability really high?

A: No, nothing was really high on him at first; everything was about the same. He came back that evening and stated the pain was worse, said his appetite was decreasing but he was not nauseated any more. I percussed his lower abdomen where he said the pain was. He said he had tenderness on the left side. When I did the rectal and came to the left, he jumped the first time, but when I came to the left a second time, it wasn't sore. I came up with non-specific abdominal pain which was the high one on the computer. The computer also had appendicitis and diverticulitis high enough so that I put it down as a rule-out. I also ruled out irritable colon. I kept him NPO and told him to come back and see me. Next day he came back saying the pain was worse. The exam was still normal. That's when I wrote that whenever I was around him he was in pain, but when I didn't see him, he

was fine. The computer finally kicked out non-specific abdominal pain as the diagnosis. I finally wrote on his record that it was hard for me to accept the fact that this patient is sick. The XO and CO stopped this one because the crew was getting upset with him.

Q: Was the computer any help in this case?

A: Yes and no because it gave me some diagnoses to consider. Then I had to go back and do some more research on my own and put everything together. You know, he had a little of the diverticulitis symptoms, he had some appy symptoms, and some non-sap symptoms, and some bowel obstruction symptoms, too.

Q: What if the computer had said with all of them split like that, the diagnosis is non-sap. Would that have helped you?

A: Yes. I would have gone along with the non-sap. Which is generally the only thing you can say, let's go with non-specific abdominal pain with a rule-out differential diagnosis.

Q: OK, tell us about H.

A: He said, "I got this pain down on the right lower quadrant inguinal area, no bowel changes or change in appetite." He said it just appeared there when he woke up. It was intermittent to a mild degree and nothing aggravated or relieved it. He denied trauma or strain. Aspirin relieved it occasionally. The abdominal exam was in normal limits; tenderness noted in right inguinal area. I thought he had an inguinal hernia but he was negative for that. So I came up with a muscle spasm of the inguinal ligament; ruled out the inguinal hernia; gave him directions - no heavy lifting. I saw him five days later, and he told me the pain was the same, he'd just gotten used to it

being there. During this period, he was chief-of-the-watch and I was relieving him so I'd see him every watch and say, "How are you feeling?", and he'd say, "Just about the same." I didn't even associate him with having any kind of abdominal pain. I didn't run it through the computer.

Q: Any general comments?

A: If the CO and XO don't like a particular corpsman, they might say, "Tell me what the computer says; I don't care what you say." But most of the corpsmen in the fleet now are good, and when you're out there underwater, anything that'll help back you up fast like this would be great. It takes you 10 hours to hunt and research through all the books to get all the information you can get in 15 minutes with the computer. So it's good just as long as the CO and XO don't start believing the computer over the corpsman. So, as far as me liking it, I loved it.

Q: Have you evacuated anybody at any time?

A: On the first run, I evacuated a head injury. I thought it was subdural hematoma and he was exhibiting all the signs and symptoms of it. Got him to the hospital and they said it was a severe concussion.

Q: Have you ever had any problem with somebody who comes in with chest pain where you worry about a possible heart attack?

A: Not yet.

Q: But you feel you'd like some help with that particular one?

A: As far as training. You know, a training type tape would be interesting.

Q: If you had one that worked pretty much as the abdominal tape, would that be helpful?

A: I think so.

- Q: Do you feel that the time you spent while you were at sea running cases was helpful?
- A: Yes. I have found, though, that with the computer I've been using the check-off sheet. Doing an abdominal exam without that now I'm forgetting stuff whereas before I didn't. I've become lazy and dependent on the form now but I'm carrying the form with me so no problem.
- Q: Are you going to continue to carry that form with you?
- A: I want to continue to carry this tape with me. I want to take this tape back to sea with me.
- Q: Well, we'll let you take the Radiation Record tape with you.
- A: No, I want to take the abdominal pain tape back with me, too.
- Q: Well, we'll talk about it.
- A: I would very much like it. Even if I've got to just copy it. I was down to the Navy Health School in Portsmouth and was asked many questions about this.
- Q: What did you say?
- A: I was very receptive. I told them it should be put out in the fleet. I said I had had it at sea with me last run. I told them what it was and how it worked and that I really liked it. They were like I was when I first started: is the CO going to believe me or this damn computer. After these trials, I'd like it out there. It gives you something to fall back to. Instead of punting, you can fall back to the computer.

APPENDIX B
EDITED TRANSCRIPTS OF CO/XO DEBRIEFINGS

EDITED TRANSCRIPT
DEBRIEFING OF CO & XO - BOAT #1

Q: Can you comment on how the computer programs that you had on board helped you or hindered you?

XO: A couple of problems we had that weren't included in the play acting. One of our patients got appendicitis. That was easy; I felt very certain that was it.

Q: Would you say that the computer program played any role at all?

XO: None at all.

Q: (TO CO) Did the computer program help at all, or play any role, in the actual evacuation; your decision making?

CO: Not really. Our mission says that we're to remain on a war footing and it's true, we do, we play like that. But we know that it's peacetime. Now if the defense condition increased, I would look a lot harder at a medical evacuation. That kind of atmosphere was never present, it was never a tactical situation which would have, by itself, precluded a MEDEVAC, and the thing that we considered consistently throughout this thing was the likelihood for successful treatment on board.

Q: Did the corpsman bring with him a copy of the printout when he first approached you?

CO: Yes.

Q: Did you take a look at it?

CO: Yes.

Q: Why did you take a look at it?

CO: I liked to see the numbers with respect to the diagnosis percentages. For instance, if it comes out, as it did in this case, 95% probability of appendicitis and the other percentage points were scattered 2 or 3 for this or that, then I feel very certain in my mind and it's just another indicator to help me believe this diagnosis.

Q: Have you ever interacted with the corpsman on the question of evacuating a seriously ill patient?

CO: Oh, yes.

Q: Would you say that the manner of the interaction would change with the computer there?

CO: I like the list of symptoms. It was a great overall view that you could look at and say this is what he thinks and give it consideration, then he could always list the additional ones. We looked at that and said that these are the things that have gone into making the diagnosis. You get a good feeling for whether the Doc has taken everything into account.

Q: So you felt that by having that printout you knew that he had at least checked with these things.

CO: Yes. That's a precise list of criteria.

Q: And what about at the bottom line where we give you some numbers here.

XO: The bottom line didn't make a lot of difference. I felt the corpsman was adequately trained to make a recommendation based on what was documented fact.

CO: By itself, whether or not the pain moves from the upper left quadrant to the lower right doesn't mean anything

- to me. It's the sum total when I get to the bottom line.
- Q: (TO CO) So you found the bottom line to be valuable. This put it together for you.
- CO: Yes, that's right. What are the numbers. The numbers are helpful.
- Q: I'd like to go back a bit. You said you did get the printout and you did look at it and you did make a value judgment on it. It's pretty solidly in favor of appendicitis and that fits with what the corpsman was saying. At that point you said this is just another useful piece of information.
- XO: He still brought his notes up and his textbooks and we discussed Murphy's march of symptoms - standard diagnostic procedure.
- Q: What I understand from you is that it was not an overwhelming thing but it was nice having there. Given the choice between having it and not having it, how do you feel?
- CO: I'd like to have it.
- Q: Why?
- CO: Because it's another data facet - the most difficult decision I have to make is a medical decision because I'm not trained and my corpsman is not a physician. Doc doesn't always have the subtleties that an M.D. would or the treatment that a guy might require. So I like to be absolutely sure that it is what he thinks it is so I can go to the book and get a standard treatment.
- Q: Any comments on other cases?
- CO: When we did our play acting cases, one came up with a diagnosis that wasn't clear-cut. When somebody gives you a diagnosis of 75% non-specific abdominal pain, I still don't know what it is. Or what to do about it. That's what one of them turned out to be: computer diagnosis, initially, was non-specific abdominal pain after the second day, the computer placed the highest probability on acute appendicitis, but the numbers were 45% versus 39%. What I'm saying there is, what is it? What does this mean?
- Q: So you have a problem with getting the numbers and saying well what do I do with that information.
- CO: That's right. We had another one that was 92% appendicitis and that was one of the play acting guys. It was 92% and I believed that but once again I confirmed it with what the book said. Rather than raw numbers like that, it would be good to get into like how much time before you should see some next event or how much time do I have to get this guy to a medical officer. That's the final decision you have to make - how much time do I have. How much time does it usually take to get to the next event if this probability is true?
- Q: Any more cases?
- XO: This was a tough one; a 24-year-old male reported to the Doc complaining about abdominal pain, upper left side.
- Q: This is a real case, right?
- XO: Right.
- Q: Tell us about this case.
- XO: Because of the pain, the man was taken off the watch bill. In fact, we had him relieved on a mid-watch because he was

doubled over. Other symptoms beside pain that were remarkable were a decrease in bowel sounds, which means nothing to me. Paralyzed ilium or whatever that other business is. We had to decide on the diagnosis: A possible acute abdomen? That was the corpsman's initial diagnosis. Something's wrong with the abdomen. We knew that. The Doc's secondary diagnosis was diverticulitis. But the computer diagnosis said non-specific abdominal pain. I pushed Doc for an answer - what's the diagnosis? We treated him for a couple or three days, basically bed rest; we gave him a pain killer. I don't remember exactly what the medication was. I didn't feel a sense of fear for his well-being. I felt that he would recover. We decided not to MEDEVAC. We're still not sure what he had. It could be that the condition was stress related. If some people get in a tight spot, they get a belly ache. Some people get headaches. We started taking a good look at what this guy was doing. He drinks a lot of coffee. He eats a lot of sugar. One of the ways we treated him after the initial bed rest and letting him sleep for a while was basically control his diet. But it recurred again, not quite as bad, but it did recur.

Q: When it recurred, did the corpsman give you any new reassessment? Did he run it through the computer again?

XO: No. Like I said, we just don't know what it was and we still don't have a real diagnosis.

Q: So getting back to the initial time that the corpsman came to you about this patient, you were taking a look at whether to evacuate. Again, with

the appendicitis case, you saw that Doc was very clear on what he thought was going on. He presented his case with Murphy's march of symptoms, etc., and you said I confirm this. He handed you the computer printout which strongly indicated appendicitis.

XO: It took me 10 minutes to make this decision.

Q: OK, now with this patient, it's an entirely different situation. Doc was not sure, he couldn't pin down anything; he couldn't make a good case to convince you that something was going on and, in fact, the computer had a different opinion from what Doc had. Doc had a specific diagnosis in mind when he said diverticulitis but he said I want to rule out an acute abdomen because that's the thing I'm worried about first. And the computer came up and said non-specific abdominal pain.

CO: See, that's the key. When you say to me acute appendicitis, I think peritonitis. That says this guy could die. But this fellow with the non-specific abdominal pain, I knew he was hurting but I also knew he wasn't going to die.

Q: It sounds like he did, indeed, have non-specific abdominal pain. I'd like to stay on this because here's a case where the corpsman said one thing and the computer said another thing and you made your decision.

CO: Yes.

Q: What happened? Did you put any weight at all on the computer?

CO: Yes. I believed it was non-specific abdominal pain.

Q: The corpsman mentions possible small

bowel obstruction?

CO: Yes.

Q: So he thought maybe small bowel obstruction but he wasn't making a big thing over it. He said, "I'm worried."

CO: He said, "My initial indications are that of 10 symptoms, he's got three." He said, "I'm going to look at it as though it isn't that," and as it turned out that was OK.

Q: OK, now, you said you went with the computer diagnosis. What do you mean by that?

CO: I didn't think it was an acute abdomen.

Q: But Doc said possible acute abdomen.

CO: Well, after a while he just said non-specific. There was no clear switch point. Just after a couple of days. Once again, none of the laboratory indications were there so that things were tending to rule out the acute abdomen.

Q: We couldn't have hoped for anything better as far as a sea trial goes because what you have was a real case of appendicitis and what at this point sounds like a real case of non-specific abdominal pain. We had a case where everybody agreed - the computer program, the CO, the XO, the corpsman - all agreed it was appendicitis and required evacuation. Then we had another case where people were scratching their heads, the computer was very definite about non-specific abdominal pain and the people kind of went along.

XO: It took us two to three days to

agree with the computer.

Q: So the XO felt it was non-specific abdominal pain; the CO felt it was maybe, looking at the worse case just in case it was that; and I'd like again to ask how important a role do you think the computer played in that case?

CO: I think it stated the fact that there wasn't an acute abdomen, and it helped us feel certain of that. In that case, I think it was very important.

Q: I'd like to summarize by just re-addressing this question: would you like to have the computer or not.

CO: I'd like to have it. I feel, once again, that it's a confirmation tool for standard diagnostic techniques. It's just another indicator and a very important one. For that reason alone, I think it's certainly worth it.

Q: How about you, XO?

XO: I feel the same.

EDITED TRANSCRIPT
DEBRIEFING OF CO & XO - BOAT #2

Q: You say you only had one patient. Please tell us about him.

CO: He did a fine job. He's a ham anyway.

Q: Tell us what happened from the time that the exercise started for you, and what happened from your viewpoint.

CO: Well, I was informed by the corpsman that F__ was ill and it might be appendicitis and it might not be. He said there are enough clues to indicate that it's appendicitis, yet there are some key things that are

missing. One, he doesn't have a temperature. Another one is the white blood cell count was not up as it should have been. But he put the data in the computer and punched out the program and it said the probability of appendicitis was pretty high. But when he went back and did some more tests and put the data in the computer again, apparently, he either added some information that clarified a few hazy points or he removed some information that the second time around he realized was not valid. The probability of appendicitis the second time was lower than it was the first and in his mind it was lower, too, because his tests showed that and sort of convinced him that it wasn't appendicitis. He was not going to recommend MEDEVAC based on his findings but he was going to keep a close eye on him to see if there were any changes. I played it straight. He said F__ might have appendicitis. I said OK, and I told the Exec to get the Navigator for me. I wanted to take a look at the chart and see where the nearest drop point might be if we had to go talk to somebody. I guess maybe Doc was convinced that I thought it was real, too.

Q: Can you tell us about the first interaction with Doc? What was said and where any discussion about the computer program came into it.

XO: It appeared to me that he was, at the outset, leaning toward MEDEVAC because so many things seemed to indicate appendicitis. I said, "Well, how about that program we brought along." He said, "I've got sort of a confirmation from it." And I could sense that he was trying to be sure that the machine wasn't

running the decision. I did sense a little reservation that he wanted to have another look at him, but his initial diagnosis, at least, was concurred with by the computer. So then when he went back and did the second evaluation, that is when he came back to say there are too many things that are a little fishy here. I don't think that he suspected that it was a put up job, but I think he was suspicious. He said, "There's something wrong; things aren't ringing true because I should be seeing a temperature and he never did have a temperature." But I think he was happy to have the computer there just saying, "Yeah, you're doing a pretty good job; you've got all the symptoms and I concur with you that it is probably appendicitis," but he wasn't so sure of the computer that it drove the whole show. He's a good clinician, I think, and he's good at taking care of people and diagnosing their problems and so I think he was using his experience and background more than, say, some less experienced junior corpsman might. I don't think he let the computer program sway him but I'm sure he felt good there was something else there confirming his diagnosis.

CO: I think the real quandary, one I'm sure is going to come up one of these days, is that the corpsman says it's appendicitis and the computer program says no it isn't, or you've got a 55% probability that it's appendicitis. What do you do then? I mean that becomes a problem for the Captain.

Q: What do you think you'd do?

CO: Well, it depends. It depends on who the corpsman is, who the patient is that has it, where we are in a patrol cycle, or what part of the world we are in. If we're in transit, there's no question

about it. I'd go up and tell the world that I've got to MEDEVAC a guy and I'm in this situation saying, "Help." If we're on patrol and the corpsman thinks that he can handle it with antibiotics and rest and the guy is in a reasonably good physical condition and he recommends that, I'll probably go along with that. Because I have seen a guy, a quartermaster, who was grossly overweight, have an attack of appendicitis and neither the doctor nor the corpsman were certain right off the bat that it was appendicitis. They said with his age and his physical condition, it could be a heart attack. So they laid him down and watched him and treated him as though it was appendicitis - massive doses of antibiotics and IV's constantly and in 13 days, 14 days he's back on his feet standing watch again. We didn't abort the patrol, didn't cut him open, and when we got back into port, we sent him up to have an examination and they said, "OK, we're going to take out your appendix." When they cut him open they found his appendix had ruptured and the massive doses of antibiotics had pulled him through. No peritonitis.

Q: If the computer and corpsman had disagreed in that kind of situation, what do you think you would have done?

CO: It's hard to say. Again, it is a question of knowing who my corpsman is and his capabilities. If he said it was appendicitis and we ought to MEDEVAC the guy, I would lean heavily towards doing that. If he said it was not appendicitis and the program, the computer, said it was appendicitis, then well, first of all, I don't think that will happen; I really don't think it will happen.

Q: But if it did?

CO: If it did, it would be an unusual situation. I think I'd go with the corpsman. But again, I can't say that until I'm there.

Q: Why would you go with the corpsman?

CO: Because I think my corpsman is capable of making a valid diagnosis.

Q: If it was your present corpsman, you'd go with him?

CO: Yes, I would.

Q: Have you had corpsmen serve under you that you didn't feel the same way that you do toward Doc?

CO: Yes.

Q: In that kind of situation, what do you think your reaction might be?

CO: I would drill the corpsman a lot more. I'd sit down with him and go through step by step what he put into the computer to find out why the computer says it's appendicitis and he says it isn't: what is he looking at that the computer is not looking at. But I think the possibility of that happening is not great.

Q: So you see the computer in that situation, at least, as giving you a guide for checking the corpsman?

CO: Yes. It certainly would cause me to question the corpsman's diagnosis and would have me telling him to go back and inspect again, be more thorough. I'd say, "Send me in the Manual to show me what you're doing and explain it all to me because I'm not a doctor." I've had corpsmen

explain things to me and while they're explaining things to me they realize they missed this or added that or paid attention to this and not that. So if they talk it through with somebody, usually they'll find out what they're omitting.

Q: If that kind of situation arose, can you imagine what might happen to the relationship you have with your corpsman? Can you see it as a positive or a negative event, or neither?

C0: I think I can see it as a positive event. Whether it's going to be positive, negative or neutral depends on how you handle it. If you hold him up to ridicule because the computer was right and he wasn't, then that's going to be a negative event and it isn't worth my time trying to do that. But you can use it as a learning situation: "OK, here's what was not considered and here's what you put into the computer, yet you didn't consider it yourself." Then I think it can be of benefit. As long as he sees that I don't say, "All right, Doc, you blew it; I'm going to knock you down on your evals." That's self-defeating.

Q: Other comments?

C0: I think it is important to be able to validate that the program is working before it is used.

Q: You think there might be a malfunction on board for some reason and you'd like to have a way of checking that.

C0: That's right. There's always the chance that the Doc got in a hurry and, while the tape is still in

there, turned the machine off and that's going to scramble part of the program. The chances are there. If you can verify the program by putting in a given set of values for everything you're supposed to look at and if it comes up between 99 and 100%, then you know the program's good. If it comes up less than 99%, then something is scrambled in the program.

Q: How easily were you able to interpret the diagnosis probabilities?

C0: I'm not sure. 98% I would feel good about. 55% or 35%, I don't know. If it's like a weapons system effectiveness number where you take all the decimal fractions and multiply them together and come up with a number considerably smaller than what you start off with - that's one thing. But if there's some other way to apply them ... well, not being a statistician, I would have to go to somebody for help or go to the program manual to find out what it means. You could give a little brochure that goes along with it and says in the following program, if items a, b, and c are between 55 and 85% for all of them, then here's your diagnosis.

Q: Did Doc show you a printout with the recommendation on it saying this is a possible diagnosis and here 1, 2, 3 is what you should initially consider?

C0: Yeah, I remember something like that.

X0: Yes, I thought it said ... it gave probable appendicitis.

Q: The last line of questioning is, if you can, each of you, picture the trials that happened and imagine that they really did happen. If you would, just comment on any role that the computer might have had in your decision making. Did you get anything

out of its being there and why.

XO: I think that the path that the corpsman was going to pursue, a series of monitorings every two hours, was ideally suited to plugging numbers back in and seeing what the trend was. The likelihood of appendicitis would get more evident or could go the other way.

CO: He wanted to put him to bed and start an IV and take another blood test in two hours. I said I thought the idea was a little too severe for a "probable" and asked for an alternative. So he put him to bed with clear liquids only and another CBC in two hours and got ready to start IV's with antibiotics. The first printout from the computer was 74.65% appendicitis and 24% non-specific abdominal infection, so it wasn't high. Had it really been appendicitis? I have to check the date, but had it really been appendicitis, we were in a position where I would have called for a MEDEVAC. No question about it. F__ is about 255 pounds on a frame that doesn't support 255 pounds and he could get into serious complications. So that's why I would MEDEVAC him. If he came up with appendicitis under any condition, he is the kind of guy I'd MEDEVAC.

Q: Do you think the computer output would have contributed to a MEDEVAC decision?

CO: Oh, yes.

Q: In what way?

CO: I think that it would help dispel any second thoughts I had about whether I should MEDEVAC a guy or

not. I mean if the corpsman said, "He's got appendicitis, and I think we ought to MEDEVAC him because I don't want to handle him on board", and the computer said, yes, 90% he's got appendicitis, I would think, "OK, that's two pseudo-independent checks that he's got it."

EDITED TRANSCRIPT
DEBRIEFING OF CO & XO - BOAT #3

Q: Tell us what happened with the first patient.

XO: In that first case, it never got to the real question of should we evacuate him. At that point, of course, both of us probably would have gotten in on it. I knew what was going on but didn't really get into the decision making part of it. I think it was a valid test of the computer and was approached honestly. Doc used the machine in that case. I think it gave him a little more confidence in what he was talking to the Captain about.

Q: Could you elaborate on that?

XO: The first case did not come off as a test; it came off with Doc really believing that it was real. My impression was that he went to use the program because he wanted to compare that to his own ideas and when he presented the whole thing to the Captain, the program gave him more confidence in what he had diagnosed himself.

Q: How far into the drill did you consider evacuating this man?

XO: Even now, I don't know what the diagnosis was supposed to be, but we never got to the point where we were even seriously considering evacuation.

Q: So you did what you ordinarily would have

done?

X0: That's right.

Q: (TO C0) Please tell us from the beginning your impressions of the first case.

C0: It was a very good experience. The corpsman thought it could be the real thing because the patient had been drinking coffee and had raised his temperature. The corpsman started to observe him for further developments, and then he used the computer to check the probabilities and those said to wait and see also. My feeling was that I had a corpsman with a lot of knowledge and practical experience and the computer with its probabilities essentially saying the same thing. I believe the corpsman was independent in his judgment as opposed to putting too much trust in the computer. I felt confident that it gave good practical, statistical data to reinforce the corpsman's own opinion, but I think it'd probably be good for the corpsman to make his own judgment and then use the computer, so that he's not overly influenced by the computer ahead of time. It's nice to have the printout there from the computer, in black and white, and be able to see just where the statistical data was broken down. I felt pretty good about it, but it seems to me that it would be helpful to have some sort of program to give us data on what to do for a patient. Also, there might be a case some day where it may be a corpsman not as experienced as the one we have now who would need even more support in evaluating a patient. You could go into more

detail and cover more types of problems.

Q: How would you react if there was a conflict between the corpsman and the computer?

C0: I'd have to just go through the decision making process and consider the alternatives. What's the probability that this one's right over the other, and then make a decision. That's what I get paid for. I can't say which way I would go. Probably in that case, I'd go back and read in the corpsman's medical books to try to get a third opinion on what to base my decision.

Q: In that situation, what role do you see for the computer. Would you even want it there?

C0: I think, in either case, I'd like to see the system there. Agreement reinforces; disagreement gives me another opinion to look at. I'm no medical expert, neither is the X0. The corpsman is the medical expert and we hang our hat a lot on what he says. If there is some other way to look at the symptoms and what they mean, then that's helpful to us. We need to know what the alternative is and too many times we haven't known the alternatives and so we'd lock in on something. It's like a horse with blinders - you look in one direction; you're not seeing what's in the other direction. The computer program gives another direction to look.

Q: I'm putting words in your mouth, but do you see it as another medical presence to rely on?

C0: That's right. It's a medical library; a source of consultation.

Q: You don't see it as a threat to corpsman or a replacement for him?

CO: No, the corpsman's my expert. I expect him to give me his analysis and then say, "Oh, by the way, here's another thing;" and it either agrees or doesn't agree with him.

XO: When you were talking about expanding, I recommend that when you consider expansion, only consider serious conditions. If you end up with a thing that tells you to wipe your nose after you blow it, it's not going to get used. However, when your experienced corpsmen start saying they have run into a condition or diagnosis they would like to have some help with, then those are the areas that should be concentrated on.

Q: Could you summarize your views about having this system aboard your ship?

CO: OK. We already have the computer, it's right there, we use it for a number of other things. It's a big hunk of machinery and the copier that comes with it is already there. So the more ways we can use the machine usefully, the better. We don't have a number of experts, we've got only one expert in the medical field. The machine provides the statistical backup and something for the corpsman to compare with. The programs don't take up room and we can use the program any time. If it's going to be useful to me in my decision-making process, I'd want it with me while I'm out there by myself.

EDITED TRANSCRIPT
DEBRIEFING OF CO & XO - BOAT #4

Q: Would you comment on how the simulated patients went?

CO: I thought the computer program was useful in confirming what the Doc already diagnosed. I think he's a very good corpsman. In each case, his diagnosis was pretty close to the computer diagnosis. I went with what he had to say. I think Petty Officer B is the one who first showed up with a problem. I don't think Doc knew anything about it. I thought the way he handled the case was good, and I thought that the tape just backed up his diagnosis. Like I said, I still went with what he had to say.

Q: The Chief really did tell him that he was going to refer him when he came back?

XO: Yes, in fact, he wrote out and I think turned in the paperwork for what amounts to a referral sheet for use upon return to port.

CO: It was maybe the most interesting of the three to me. That was the case where the Doc kept seeing him and wasn't sure what he wanted to do. He had come up with, both by the computer and his other resources, four possible diagnoses and the computer gave about 60% probability of appendicitis, but there was a 40% probability, or something near that, of something else. Acute appendicitis could have had some impact on the ship's operations; but the lesser diagnosis would have had very little impact.

XO: Well, after the Doc explained to me all the symptoms, I remember concluding that I thought he was probably right in this case, and the computer probabilities weren't correct for the symptoms as presented. I had no idea what the right answer was but one of the reasons I found it interesting was that the Skipper, Doc and myself, although we were looking at what the computer presented, weren't hung up on these probabilities. I guess I don't

place a lot of credence in those probabilities, but I think the computer tape is good in regard to being a pretty comprehensive reference for what the different diagnoses are and what the different symptoms that might be related are.

Q: You see it as a guide rather than a final answer.

CO: I'd feel very comfortable out there with a junior corpsman who was relying on the computer tapes to diagnose instead of relying on his own judgment.

XO: I don't think that was happening with our ship.

CO: I think the corpsmen really ought to understand that it's just a tool and they need to have the clinical experience in diagnosing things without the aid of a tape. For one thing, if it's not getting good information, you get trash out of it. No matter how good the computer program is.

Q: (TO CO) Can you foresee how your decision making would be if you had a real patient with a junior corpsman whose clinical experience is low trying to make a diagnosis?

CO: Well, you know, in a case like that I'd get the books out and start reading.

Q: You'd fall back to his references?

CO: Yes. I'd use the tape, I'd use what he said, and I'd also look in his books. Then I'd probably be conservative. If I've got somebody out there that I don't feel has the experience our Doc has, I'd be very tempted to get rid of a guy much sooner. I don't think that the

computer could replace experience at that point because the guy has basically got to know what he's doing. I just don't think the computer could handle that.

Q: Did the Chief give you anything that resembled a printout or something in writing or some indication of what the computer had said?

CO: Yes. He usually had a 3x5 card. I'd say, "Hey, what did the computer say? Did you run the computer tape?" He said, "Yes." I said, "What did it show?" And on this 3x5 card he had appendicitis 67%, gas 3%, etc.

Q: Did having the computer programs influence your relationship with your corpsman?

CO: Well, this was my first patrol, but, from the way I have treated my previous corpsman, I'd say it didn't change. It was something nice to plug in all the symptoms and see what it said. If it agreed with Doc, that was great. If there was some disagreement, we sat down and went over the reason why he was leaning toward the second probability in the program and I agreed with what he said.

XO: If that computer hadn't been there, I would have wanted him to do one thing that I really didn't do this time. We had a previous case where we did evacuate a guy who had a head injury and it seemed difficult to pin down symptoms and a diagnosis. I remember very distinctly that that time the Doc and I went through various books trying to find information that would help make the decision. In these cases, I felt comfortable with the computer's information and beyond, I think, one or two books, we didn't dig that far. Maybe that's bad, I don't know, but

I felt more satisfied with the information given by the computer.

Q: What if the computer said that you had a 97% probability of appendicitis and the Doc had said, "No, I don't agree."

CO: What would I do?

Q: Yes.

CO: Well, if Doc sat down and went through the stuff like he did in these cases, and I was convinced he was right, I'd go with what he said and ignore the computer.

Q: Suppose the computer had been on board, say, over a two-year period and had proven that it had an accuracy rate of close to 100%.

CO: I'd still go with the corpsman because even if the computer program is good, it can't cover every case. There's bound to be a case that's not going to be on the tape.

Q: In general, how do you feel about the system?

CO: I think it's a worthwhile aid. As the XO says, if the corpsman is agreeing with the computer and there's only a couple of things you want to check, it cuts down on the work of going through the books. One of the reasons you do that, or at least I felt I did it as XO, was to make sure that the corpsman had looked at everything and that he hadn't missed something while reading through one of those thick tomes. It gives him a chance to explain his reasoning and a corpsman ought to have a very good and very logical approach to the problem.

Q: How would you feel about expanding to cover other areas?

CO: If you can write a good program to cover other areas, I think you ought to do it.

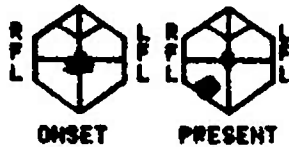
APPENDIX C

COMPUTER PRINTOUTS OF ACTUAL PATIENTS EVALUATED ON SUBMARINE #1

DATASHEET: Acute Abdominal Pain---
PAGE 1- History

Patient SSN:
Time/Date:
Age:

PAIN SITE:



TYPE OF PAIN: INTERMITTENT STEADY COLICKY

SEVERITY: MODERATE/SEVERE

PROGRESS: BETTER/ SAME WORSE

DURATION: <12h/12-24h/24-48h/48+h

AGGRAVATING FACTORS: MOVEMENT COUGH/BREATHING/FOOD/OTHER/NONE

RELIEVING FACTORS: LYING STILL/VOMITING/ANTACIDS/FOOD/OTHER/NONE

OTHER SYMPTOMS

NAUSEA: YES/NO

VOMITING: YES/NO

APPETITE: DECREASED NORMAL

JAUNDICE: YES/NO

BOWELS: NORMAL/CONSTIPATED/DIARRHEA/BLOOD IN STOOL/MUCUS IN STOOL

URINATION: NORMAL/FREQUENCY/PAINFUL/DARK URINE/BLOOD IN URINE

PAST HISTORY

PREVIOUS INDIGESTION: YES/NO

PREVIOUS SIMILAR PAIN: YES/NO

PREVIOUS SURGERY: YES/NO

PREVIOUS ILLNESSES: YES/NO (Comment on pertinent on back)

TAKING MEDICATIONS: YES/NO

(Physical Exam on next sheet)

FIGURE 1. Data sheet for history completed by Corpsman. Actual case of appendicitis.

DATASHEET: Acute Abdominal Pain---
PAGE 2-Physical Exam

Patient SSN:
Time/Date:

VITAL SIGNS TEMP-99.2 PULSE- 72 BP- 130/80 RESP- 16

GENERAL EXAM

MOOD: NORMAL/DISTRESSED/ANXIOUS

COLOR: NORMAL/PALB/FLUSHED/JAUNDICED/CYANOTIC

ABDOMINAL EXAM

INSPECTION: NORMAL/VISIBLE PERISTALSIS/DECREASED ABDOMINAL MOVEMENT

BOWEL SOUNDS: NORMAL/DECREASED OR ABSENT/HYPERACTIVE

SCARS: YES/NO DISTENTION: YES/NO

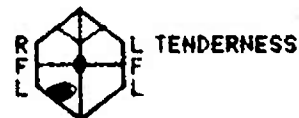
REBOUND: YES/NO GUARDING: YES/NO

RIGIDITY: YES/NO MASSES: YES/NO

MURPHY'S SIGN: PRESENT/ABSENT

RECTAL EXAM: NORMAL/MASS FELT/GUAIAC TEST FOR BLOOD POSITIVE

TENDERNESS- ON LEFT/ON RIGHT/GENERAL



LAB TESTS

HEMATOCRIT- N.E.

WHITE CELL COUNT- 25,650

URINALYSIS (Routine and Microscopic)- N.E.

FIGURE 2. Data sheet for physical examination completed by Corpsman. Actual case of appendicitis.

PATIENT SSN:

TIME/DATE ENTERED:

SYMPTOMS	
MALE AGE 20-29 ONSET CENTRAL PAIN NOW RLQ COUGHING AGGRAVATES NOTHING RELIEVES PAIN NOW WORSE DURATION <12 HRS PAIN STEADY PAIN IS MODERATE NAUSEA PRESENT VOMITING PRESENT APPETITE NORMAL NO PREV. INDIGESTION NO JAUNDICE BOWELS NORMAL URINATION NORMAL NO PREV. SIM. PAIN NO PREV. ABD. SURG.	NOT TAKING MEDS MOOD NORMAL COLOR PALE ABD MOVEMENT NORMAL NO ABD SCARS PRESENT NO ABD DISTENTION TENDERNESS RLQ REBOUND PRESENT NO GUARDING NO RIGIDITY NO ABD MASSES MURPHY'S NEGATIVE DECREASED BOWEL SOUNDS RECTAL - NORMAL
I APPEND I DIVERT I PERFDU I HONSAP I CHOLE I SMBOBS I RCOLIC I DYSP I	
I 96.58 I 0.00 I 0.00 I 3.42 I 0.00 I 0.00 I 0.00 I 0.00	

To make copy type COPY (RETURN). Key RETURN to continue.

FIGURE 3. Computer display summarizing data entered from data sheets of Figures 1 and 2. Diagnostic probabilities are shown as a percentage. Computer "diagnosis" in this case favored appendicitis. This patient was evacuated for appendicitis from a patrolling FBM submarine.

STRONGLY SUGGESTIVE

Recommend you treat as presumed ACUTE APPENDICITIS---

If you agree with this diagnosis, consider the following:

1. Prepare for probable evacuation (mission permitting).
2. Keep patient NPO; begin IV fluids and antibiotics; start N-G suction.
3. Go to Intensive Care program (ABIC) for more detailed help on patient management.

For HARDCOPY enter COPY. Key RETURN to continue.

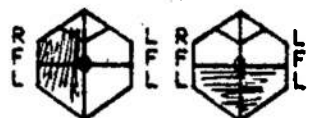
FIGURE 4. Computer's diagnosis statement and initial recommendation. Language is designed to allow corpsman flexibility in considering his options.

DATASHEET: Acute Abdominal Pain---
PAGE 1- History

Patient SSN:
Time/Date:
Age:

PAIN

SITE:



ONSET

PRESENT

TYPE OF PAIN: INTERMITTENT/STEADY/COLICKY

SEVERITY: MODERATE/SEVERE

PROGRESS: BETTER/SAME/WORSE

DURATION: <12h/12-24h/24-48h/48+h

AGGRAVATING FACTORS: MOVEMENT/COUGH/BREATHING/FOOD/OTHER/NONE

RELIEVING FACTORS: LYING STILL/VOMITING/ANTACIDS/FOOD/OTHER/NONE

OTHER SYMPTOMS

NAUSEA: YES/NO

VOMITING: YES/NO

APPETITE: DECREASED/NORMAL

JAUNDICE: YES/NO

BOWELS: NORMAL/CONSTIPATED/DIARRHEA/BLOOD IN STOOL/MUCUS IN STOOL

URINATION: NORMAL/FREQUENCY/PAINFUL/DARK URINE/BLOOD IN URINE

PAST HISTORY

PREVIOUS INDIGESTION: YES/NO

PREVIOUS SIMILAR PAIN: YES/NO

PREVIOUS SURGERY: YES/NO

PREVIOUS ILLNESSES: YES/NO (Comment on pertinent on back)

TAKING MEDICATIONS: YES/NO

(Physical Exam on next sheet)

FIGURE 5. Data sheet for history completed by Corpsman. Actual case of non-specific abdominal pain.

DATASHEET: Acute Abdominal Pain---
PAGE 2-Physical Exam

Patient SSN:
Time/Date:

VITAL SIGNS TEMP- 99.6 PULSE- 76 BP- 130/80 RESP- 16

GENERAL EXAM

MOOD: (NORMAL) DISTRESSED/ANXIOUS

COLOR: (NORMAL) PALE/FLUSHED/JAUNDICED/CYANOTIC

ABDOMINAL EXAM

INSPECTION: (NORMAL) VISIBLE PERISTALSIS/DECREASED ABDOMINAL MOVEMENT

BOWEL SOUNDS: NORMAL/DECREASED OR ABSENT/HYPERACTIVE

SCARS: YES/NO DISTENTION: YES/NO

REBOUND: YES/NO GUARDING: YES/NO

RIGIDITY: YES/NO MASSES: YES/NO



MURPHY'S SIGN: PRESENT/ABSENT

RECTAL EXAM: (NORMAL) MASS FELT/GUAIAC TEST FOR BLOOD POSITIVE

TENDERNESS- ON LEFT/ON RIGHT/GENERAL

LAB TESTS

HEMATOCRIT-

WHITE CELL COUNT-

URINALYSIS (Routine and Microscopic)-

FIGURE 6. Data sheet for physical examination completed by Corpsman. Actual case of non-specific abdominal pain.

PATIENT SSN:

TIME DATE ENTERED:

SYMPTOMS

MALE
AGE 28-29
PAIN ONSET RT HALF
PAIN NOW LOWER HALF
MOVEMENT AGGRAVATES
FOOD AGGRAVATES
LYING STILL RELIEVES
PAIN NOW WORSE
DURATION 48+HRS
PAIN STEADY
PAIN IS MODERATE
NO NAUSEA
NO VOMITING
APPETITE DECREASED
NO PREV. INDIGESTION
NO JAUNDICE
BOWELS NORMAL
URINATION NORMAL
NO PREV. SIM. PAIN

NO PREV. ABD. SURG.
NOT TAKING MEDS
MOOD NORMAL
COLOR NORMAL
ABD MOVEMENT NORMAL
NO ABD SCARS PRESENT
NO ABD DISTENTION
TENDER LOWER HALF
TENDER LEFT HALF
NO REBOUND
NO GUARDING
NO RIGIDITY
NO ABD MASSES
MURPHY'S NEGATIVE
DECREASED BOWEL SOUNDS
RECTAL - NORMAL

APPEND	DIVERT	PERFDO	NONSAP	CHOLE	SMBOSBS	PCOLIC	DYSP
0.13	0.00	0.00	99.77	0.00	0.00	0.00	0.10

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FIGURE 7. Computer display summarizing data entered from data sheets of Figures 5 and 6. Diagnostic probabilities are shown as a percentage. Computer "diagnosis" in this case favored non-specific abdominal pain. This patient's condition resolved after several days of careful observation, symptomatic treatment, and attention to diet.



STRONGLY SUGGESTIVE

Recommend you treat as presumed NON-SPECIFIC ABDOMINAL PAIN---

If you agree with this diagnosis, consider the following:

1. Attempt to determine cause of symptoms-
Viral or Bacterial.
2. Treatment depending on cause and severity of
symptoms: Rest, hydration, antiemetics, anti-
diarrheals, and so forth.
3. Go to NSAP program for more detailed advice.

For HARDCOPY enter COPY. Key RETURN to continue.

FIGURE 8. Computer's diagnosis statement and initial recommendation. Language is designed to allow corpsmen flexibility in considering his options.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes experience in using a computer-based system to aid in medical decision making aboard patrolling nuclear submarines. The system consists of a Tektronix 4051 desk-top microcomputer, already aboard submarines, and a computer program designed to assist hospital corpsmen in the diagnosis of patients with acute abdominal pain. This trial was designed to test user acceptance and to find whether unanticipated problems might be encountered during operational use of the system. Participating submarine Corpsmen, Executive Officers (XO), and Commanding Officers (CO) subjectively		

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assessed whether the trials permitted realistic use of the system, whether the system affected the Corpsman's professional role or his interactions with his XO or CO, and whether the system was useful in making medical evacuation (MEDEVAC) or other patient care decisions while at sea.

Four Fleet Ballistic Missile Submarines participated, each for one 2-month patrol. Each had a single Corpsman, XO, and CO. To ensure use of the system in a predictable way, preselected submarine crewmembers, trained to simulate abdominal pain, presented to the corpsman for diagnosis during patrol. The corpsmen did not know in advance that a given case might not be real. CO's and XO's also participated in each drill as if the patient were genuine, though they knew in advance that they were not. At the end of patrol, each Corpsman, XO, and CO was interviewed and these interviews were recorded and transcribed in toto.

During the study, 9 simulated and 4 genuine cases of abdominal pain were evaluated. In debriefings, all participants stated that the simulated patients appeared genuine and that this method provided for realistic use of the system. All corpsmen perceived the computer as an aid to, rather than a replacement for, their clinical judgment. The Corpsmen, and particularly the XO's and CO's, found the computer programs valuable in organizing and summarizing patient data and provided a basis for discussing MEDEVAC decisions. All stated that the system was useful in making MEDEVAC and other patient-care decisions and unanimously endorsed its use aboard submarines at sea.

Significant problems were that users found the results of the computer analysis difficult to interpret and that the hardcopy unit failed to provide legible computer printouts in 3 of 4 cases. We conclude that prior to full-scale clinical trials of this system at sea, the computer "diagnosis" must be presented in a format which is easily interpreted and most useful in making patient care decisions. Training of users in interpreting the computer output must also be improved. Failure of the hardcopy unit can be avoided by providing copy paper that is fresh and stored in a cool environment.

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